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PROCEEDINGS

OF THE

FIFTH ANNUAL CONVENTION

OF THE

Association of Railway Superintendents of Bridges and Buildings,

HELD IN NEW ORLEANS, LOUISIANA,

OCTOBER 15 AND 16, 1895.

CONCORD, N. H.:
PRINTED BY THE REPUBLICAN PRESS ASSOCIATION.
1895.

OFFICERS.

W. A. McGONAGLE, ... President.
Duluth & Iron Range Railroad, Two Harbors, Minn.

L. K. SPAFFORD, ... First Vice-President.
Kansas City, Fort Scott & Memphis Railway, Kansas City, Mo.

JAMES STANNARD, ... Second Vice-President.
Wabash Railroad, Moberly, Mo.

WALTER G. BERG, ... Third Vice-President.
Lehigh Valley Railroad, Jersey City, N. J.

JOSEPH H. CUMMIN, ... Fourth Vice-President.
Long Island Railroad, Long Island City, N. Y.

S. F. PATTERSON . . . . Secretary.
Boston & Maine Railroad, Concord, N. H.

GEORGE M. REID, ... Treasurer.
Lake Shore & Michigan Southern Railway, Cleveland, Ohio.

EXECUTIVE MEMBERS.

R. M. Peck, . . M. P. Ry. & St. L., I. M. & S. Ry., Pacific, Mo.

J. L. White, ... Texas Midland Ry., Terrell, Texas.

A. Shane, ... C., C., C. & St. Louis Ry., Lafayette, Ind.

Aaron S. Markley, Chicago & Eastern Illinois R. R., Danville, Ill.

W. M. Noon, Duluth, South Shore & Atlantic Ry., Marquette, Mich.

Joseph M. Staten, . Chesapeake & Ohio R. R., Richmond, Va.

PROCEEDINGS OF THE FIFTH ANNUAL CONVENTION

OF THE

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS,

HELD IN NEW ORLEANS, LA., OCTOBER 15 AND 16, 1895.

The convention was called to order at 10 a. m., October 15, with President G. W. Andrews in the chair, about twenty ladies being present at the opening exercises. Prayer was offered by Mr. Joseph H. Cummin.

Mr. J. L. White immediately sprung a surprise upon the convention as follows:

MR. PRESIDENT, LADIES AND GENTLEMEN:

I have been a little disappointed this morning; I expected a far more competent and worthy man than myself to make this presentation; however, I will do the best I can. I stand before you this morning with a very agreeable duty to perform in behalf of the Bridge and Building Department of the Texas Midland R. R. You remember, gentlemen, that little "one horse road," as some one saw fit to designate it last year; and you may also remember that this simple expression brought me to my feet in rather an unceremonious manner to speak in defence of my road, and in favor of the admission of our president and general manager as a member of this association; but I am proud to say that no sooner had I explained to our worthy president and members the kindly feeling which President Green entertained for this association, and his intentions in regard to the progress of our road, than he was unanimously elected as a member among us. Now of our president and general manager, I dare say nothing at present, he may be with us; I have an idea that he is in town,—if not he will be here during the convention, and he will be able to speak for himself. Of the Texas Midland Railroad, I wish to state that we can no longer claim your sympathy as a "one horse road," for I am proud to say that my prediction in Kansas City last year in regard to our road has been more than verified by our management, and the Texas Midland stands to-day, without exception, one of the finest equipped roads in the country. Our rolling stock, cars of all kinds, and loco-

motives, are the finest built; our trains are lit by electricity from the headlight on the locomotive to the marker, or tail light, on the last coach, and the interior of our coaches at night is as bright as day; our coaches are heated all through with the latest hot air improvements—doing away with the murderous stove: in fact, all the latest improvements are on our little road. Since the fourth annual convention of this association in Kansas City, our management have spent many hundreds of thousands of dollars on new road-bed, new ties, new seventy pound steel rails, rolling stock of all kinds, and on bridges and buildings,—just as I stated last year that they would do. Our schedule is as fast as any in the state; we make close connection with all the fast flyers, on the Texas & Pacific, M., K. & T., Houston & Texas Central, Cotton Belt; and I do not hesitate to say that our road-bed, track, bridges, and rolling stock are equal to any time necessary to make connection with all fast trains connecting with us. And, gentlemen, there is another point to which I wish to call your attention,—it is this; none of our older railroad men need be ashamed of having his name on the rolls of our once little "one horse railroad," for we still continue to run that two horse pay car,—promptly on the 15th of each month. Mr. President, as a member of this association I appreciate the great value of time in a convention, and beg to be forgiven for my digression from the duty conferred on me by my department. The men of the Bridge and Building Department of the Texas Midland Railroad ask the Association of Railway Superintendents of Bridges and Buildings to please accept of this beautiful banner as a memorial of the fifth annual convention, and as a token of their appreciation of the noble work being done by its members, in each and every one of their annual conventions, and by each and every committee during the year, and with all kindly feelings for the future welfare of its members, both individually and collectively, and for their families, I will let the banner speak for itself; but before turning this banner over to our beloved association, I wish to state that the men of the Bridge and Building Department, of the Texas Midland, desire to tender their heartfelt thanks to President George W. Andrews for the kind manner in which he attended to the business of getting the banner made, and wish to say that he is down on our rolls as their everlasting friend. Gentlemen, I wish to say further, that the men in my department leave it with the discretion of the members of the association whether their little present should be accepted by the president of the association for them, or by a vote of the association. Now, Mr. President, in behalf of the men of the Bridge and Building Department of the Texas Midland Railroad, I place this beautiful banner in your hands, for unveiling, with the fond hope that it may be received in the same kindly and friendly feeling in which it is tendered. Ladies and gentlemen, I thank you for your attention.

Mr. Andrews.—I ask Mr. Cummin and Mr. Heflin to unveil the banner.

The banner had on one side, "Presented by the Bridge and Building Department of the Texas Midland Railroad," and on the other, "Association of Railway Superintendents of Bridges and Buildings," encircling an emblematical design representing a railroad train crossing a bridge approaching a station building.

Mr. Andrews.—I wish to call your attention to the emblematical

meaning of the ribbon in the eagle's beak. This, however, was not done by Messrs. White and Green, although emblematical of white and green—it was done by the manufacturer.

Mr. Andrews.—In behalf of the members of this association, I accept this beautiful banner, and thank the donors most heartily for their kindness. As Mr. White has said, I plead guilty to having had a hand in designing and manufacturing the banner. The design, possibly, is partly mine, but not altogether. It was first intended to have the banner made of white and green, but owing to the manner in which the banner must be shipped each year for our convention, it was thought better not to have the white in the banner, and I then instructed the manufacturer to place the two pieces of ribbon that you see suspended from the mouth of the eagle, emblematical of the names of the two gentlemen, who were, I believe, the principal donors of this magnificent banner. It also has an emblematical meaning, which I did not describe to Mr. White—the green, that their actions may ever remain green in our memories; the white, that our association may ever remain pure and undefiled, an honor to ourselves and the railroads whom we represent. I again thank Mr. White, and, through him, the employees of the bridge and building department of the Texas Midland Railroad, by whom this magnificent banner was presented, and accept the same in behalf of our association. For the benefit of our secretary who has an idea that he is created guardian, would say that my understanding of this matter is that the banner is to be placed in possession of the president. Last year he took possession of the key, and I have never seen it. If I were to be president for another year, I should take care to see that he does not have this, and I will take care to see that it is so explained to our incoming president.

Mr. Cummin.—In order that there may be no controversy between our president and secretary, about the banner, I would suggest that we elect a standard-bearer.

Mr. White—I want it distinctly understood that the inscription is merely put on there to answer all questions in future. We may be dead and gone. I know some of us old fellows will be. Many questions will be asked—where did our association get this banner? It is a memorial of our fifth annual convention, and will answer all questions.

Calling of the roll was next in order. Thirty-one members responded as follows, viz.:

MEMBERS PRESENT AT ROLL CALL.

George W. Andrews, Philadelphia Div., B. & O. R. R., 24 Chestnut street, Philadelphia.
Cyrus P. Austin, B. & M. R. R., Medford, Mass.
Walter G. Berg, Lehigh Valley R. R., Jersey City, N. J.
J. S. Berry, S. T. S. W. Ry., Tyler, Texas.
William Berry, San Antonio & Arkansas Pass, Yoakum, Texas.
George J. Bishop, C., R. I. & P. Ry., Topeka, Kans.
Joseph H. Cummin, Long Island R. R., Long Island City, N. Y.
W. R. Damon, Louisville, Nashville & St. Louis R. R. Co., Huntingburgh, Ind.
Joseph Doll, C., C., C. & St. L. Ry. Co., Batesville, Ind.
William O. Eggleston, C. & Erie R. R., Huntington, Ind.
George E. Hanks, Flint & Pere Marquette Ry., East Saginaw, Mich.
R. L. Heflin, B. & O. Ry., Grafton, W. Va.
G. W. Hinman, Louisville & Nashville R. R. Co., Evansville, Ind.
T. H. Kelleher, New Orleans & N. E. R. R. Co., New Orleans, La.
Aaron S. Markley, Chicago & Eastern Ill. R. R. Co., Danville, Ill.
John H. Markley, Toledo, Peoria & Western Ry. Co., Peoria, Ill.
N. M. Markley, C., C., C. & St. L. Ry. Co., Arcanum, Ohio.
Charles C. Mallard, Southern Pacific Co., Algiers, La.
A. McNab, Chicago & West Michigan Ry., Holland, Mich.
H. Middaugh, Seattle, Lake Shore & Eastern Ry. Co., Seattle, Wash.
S. S. Millener, B. & O., S. W. R. R., Washington, Ind.
W. M. Noon, Duluth, South Shore & Atlantic, Marquette, Mich.
Samuel F. Patterson, Boston & Maine R.R., Concord, N.H.
G. M. Reid, Lake Shore & Michigan Southern Ry., Cleveland, Ohio.
A. Shane, C., C., C. & St. L. Ry. Co., Lafayette, Ind.
J. L. Soisson, Wheeling & Lake Erie Ry. Co., Norwolk, Ohio.
L. K. Spafford, K. C., F. S. & M. Ry., Kansas City, Mo.
James Stannard, Wabash Ry., Moberly, Mo.
Joseph M. Staten, Chesa. & Ohio, Richmond, Va.
N. W. Thompson, P., F. W. & C. Ry., Western Div., Fort Wayne, Ind.
J. L. White, Texas Midland R. R., Terrell, Texas.

The following-named gentlemen arrived later:

J. R. Harvey, St. L., I. M. & G. Ry., Little Rock, Ark.
R. J. Howell, Wheeling Bridge & Terminal Ry., Wheeling, W. Va.
J. E. Wallace, Wabash R. R., Springfield, Ill.
John Foreman, P. & R. R. R., Pottstown, Pa.
F. W. Tanner, Mo. Pac. Ry., Atchison, Kans.
G. W. Ryan, K. C., F. S. & M. Ry. Co., Thayer, Mo.
C. W. Keyser, Mo. Pac. Ry., El Dorado, Kans.
I. T. Carpenter, Lexington, Ky.
R. M. Peck, Mo. Pac. Ry. & St. L., I. M. & S., Pacific, Mo.

Mr. Andrews.—I have another pleasant duty to perform, and will state to those who have not had the pleasure of mingling with us heretofore, that at all of our meetings we have received the most kind courtesies from the firm of Sherwin, Williams &

Co. These were not merely courtesies to the members, but of a nature that have cost considerable money, and that it has all been given, I fully believe, without any hopes of return. I have had the pleasure of personally mingling with the gentlemen, and have found that their action has been of pure friendship; they have at each of our meetings always presented us with some token of esteem, and at this meeting they have presented us with magnificent badges, commemorative of this occasion, and requested us to present them to each of the members and their ladies, and I will take the pleasure of presenting them to members if they will kindly step forward. Mr. Stannard has kindly consented to distribute them.

Mr. Mallard.—I take pleasure in saying that I am instructed by Mr. Van Vleck to offer you an excursion on our road, to see the process of sugar making. We will leave this side of the river at eight o'clock, go to Calumet Plantation, where we will take a steamboat and ride on Bayou Teche, which is the richest portion of our whole state. You will there see sugar planting in its best condition. I would like the whole convention to go, and would be pleased to know as soon as possible how many there will be, so we can make proper arrangements, leaving here Thursday at eight a. m., and returning at six p. m.

Motion to accept the invitation of the Southern Pacific Co. was carried.

Mr. Kelleher.—In behalf of the Queen & Crescent, I am authorized to say that a train will be placed at the disposal of this association on Friday to go over Lake Pontchartrain, as far as the association wish to go, perhaps to Slidell, thirty miles from here.

Moved and seconded that the invitation of the Queen & Crescent be accepted, if the business of the convention permitted, and that the thanks of the association be given to both roads.

On motion, the reading of minutes of last meeting was dispensed with.

ADDRESS OF PRESIDENT ANDREWS.

GENTLEMEN OF THE AMERICAN INTERNATIONAL ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS:

By the wisdom of Him who doeth all things well, we are again permitted to meet in this, our fifth annual convention, and in doing this let us not forget to render that homage which is due from the creature to his Great Creator for his wisdom and divine blessing.

In the year about to expire the affairs of our association have moved along smoothly and successfully, and it now becomes my duty to render an account of the work of the year in which I have had the honor to preside over the affairs of our association.

In arranging the work of our last meeting for publication it was deemed advisable by a large majority of the officers to insert sufficient advertisements in the published proceedings to pay for expenses of same. That this was successfully done will be shown by the reports of our secretary and treasurer. In consideration of the fact that this venture has proven a success, I would earnestly recommend that this policy be continued.

In the early part of the year the chairman of our executive committee, at my suggestion, opened correspondence with the various hotel proprietors of Atlanta, with a view of arranging for the accommodation of our members, but, owing to the expected rush of visitors to the exposition, we found it would be impossible to get any special accommodations; we, therefore, deemed it unwise to delay, and accordingly selected New Orleans as the place for the present meeting. This was done by an almost unanimous vote of your officers, and it is hoped it will meet with your approval.

During the year our secretary has received a number of requests from railway journals for advance copies of reports; under our present system it has been impossible to comply with their request, but I believe that we should take such action at this meeting as would enable us to not only furnish advance copies to railway journals, but also to the members. This would enable them to prepare for discussion intelligently. In view of this fact I would recommend that all committees be required to place a copy of their reports in the hands of the secretary not later than one month prior to annual convention of each year, and that the secretary be directed to have copies printed and distributed to the members and technical press on the first day of the meeting. This will give us an additional advantage in enabling us to publish the proceedings at an early date after the meeting.

During the year the *Railway Age* courteously renewed their offer of one hundred dollars as a prize to be competed for by the members of the association. While it was believed that the offer was made by the gentlemen connected with the above paper, with a view of promoting the general welfare of our association, it was deemed advisable by your officers to decline it, and the gentlemen were so notified.

In concluding, I wish to thank you for the honor conferred upon me one year ago, and at the same time assure you that my efforts will be devoted in the future, as they have in the past, for the general welfare of our organization. I also wish to thank the members for their courteous treatment at all times, and also our genial secretary, whom I have found ever ready to extend a helping hand.

Courteously and fraternally,

George W. Andrews, President.

On motion of Mr. Stannard, seconded by Mr. Cummin, report of the president was not only received, but the recommendations therein contained, relative to advertising, were adopted.

The secretary, Mr. S. F. Patterson, read petitions for membership, as follows, viz.:

J. W. Titley, Fort Worth & Den. City Ry., Clarendon, Tex.
W. S. Schenck, B. & O. R. R. (P. H. Div.), Connellsville, Pa.
James Brady, C., R. I. & Pac. Ry., Davenport, Iowa.

J. O. OLMSTEAD, Cent. Vt. R. R., St. Albans, Vt.
JOHN D. ISAACS, Sou. Pac. Ry., San Francisco, Cal.
E. LOUGHERY, Tex. & Pac. Ry., Marshall, Tex.
JOSEPH W. BOYCE, L. E. & St. L. Consolidated, Huntingburg, Ind.

The above names were referred to the committee on new members, and on their recomendation were unanimously elected.

REPORT OF SECRETARY.

CONCORD, N. H., October 8, 1895.

To the Officers and Members of the American International Association of Railway Superintendents of Bridges and Buildings:

GENTLEMEN:

Your secretary submits the following report:

Convention adjourned at Kansas City, Mo., to meet at Atlanta, Ga., October 15, 1895. Owing to the prospects of the city being crowded at that time on account of the exposition, and the committee not being able to secure satisfactory accommodations, it was decided to meet at New Orleans, La. Five hundred copies of the proceedings were printed, and nearly all of them have been distributed. Efforts were made to secure advertisements, with very satisfactory results.

Your secretary is indebted to the officers and committees for courtesies shown him, especially to those members who have rendered great service to him in his duties, and in the procuring of advertisements and new members.

We have now 115 members. Providence has smiled upon us during the year, none of our members having died.

FINANCIAL.

DR.

Received from new members	$100.00	
" for assessments	62.00	
" " dues	139.00	
" " advertisements	285.50	
		$586.50

CR.

By cash paid out for which I hold vouchers	$374.75	
Postage	23.34	
Paid treasurer, cash	188.41	
		$586.50

Respectfully submitted,

S. F. PATTERSON, Secretary.

REPORT OF TREASURER.

NEW ORLEANS, LA., October 15, 1895.

To the Officers and Members of the Association of Bridges and Buildings:

Your treasurer submits the following report for year ending October 15, 1895.

Cash on hand October 15, 1894	$22.27
Cash received from secretary during the year	188.41
Total on hand	$210.68

Respectfully submitted,
G. M. REID, Treasurer.

Reports of secretary and treasurer received and referred to auditing committee.

The president appointed committees as follows:

Subjects for Reports and Discussion.—Joseph H. Cummin, James Stannard, Aaron S. Markley, J. L. White, C. C. Mallard.

Auditing Committee.—Joseph M. Staten, G. W. Hinman, John H. Markley.

Nominating Committee.—W. M. Noon, N. W. Thompson, N. M. Markley.

Mr. Spafford.—I wish to say to the convention, that for the past three years I have been in bad health, and for that reason wish my name dropped, as an officer of this association, as it is very probable that I shall not continue in active railroad life much longer.

Mr. Andrews.—I would like to say to Mr. Spafford, in behalf of the members of this association, that there is not one of them but sincerely hopes that Mr. Spafford will recall that decision. We all sincerely feel that he will make us a most excellent officer; he has given us great assistance in the past, and I am confident will continue in the future; no matter in what office he may be, we feel that he should continue in office, or if that would interfere with his plans, that he remain a member.

Mr. Spafford.—I thank you and the association for the kindly feelings towards me, but I believe my duty to myself and the association prompts me in saying that I will not be able to fulfil the requirements of the office in my present health.

Mr. Cummin.—In behalf of the committee on selection of subjects for next year's meeting, I would ask if any members are inter-

ested in any particular subject, that they would reduce their suggestions to writing. and present them to the committee at the close of this session.

Mr. S. F. Patterson.—In view of the anticipated change in the by-laws, offered by Mr. Hall at the last session, would be glad to have that taken up—and I move that it be taken from the table. Seconded.

Mr. Andrews.—As Mr. Hall has not been able to be present, I will read the resolution: "To amend Article IX, section 1, of our constitution, by striking out the words 'two dollars,' and inserting the words 'three dollars,' for annual dues."

Mr. Shane.—I move to lay the motion on the table and take it up immediately after the report of the auditing committee. The members of this association will want to know the necessity of such action before it is taken. If it is apparent that we do not need the money, we do not want to vote the increase in dues. Motion seconded and carried.

Reading by secretary of amendment to the constitution offered by Mr. O. J. Travis, last year, as follows:

KANSAS CITY, MO., STATION, October 17, 1894.

To the President and Members of the American International Association of Superintendents of Bridges and Buildings:

In accordance with section 1, Article X, of the constitution of this association, I hereby give notice that I will offer as an amendment to section 1, Article I, of the constitution, the following:

This association shall be known as "American Association of Railway Bridge Builders."

O. J. TRAVIS.

Mr. Berg.—I second the motion, but I wish to say, however, that I do so, not because I am in accord with it, but simply to bring it before the house.

Motion made by Mr. Cummin and seconded, that Mr. Travis's motion be amended by striking out the words "American International," leaving the title "Association of Railway Superintendents of Bridges and Buildings." Carried.

Mr. Andrew.—This association will be now known as "Association of Railway Superintendents of Bridges and Buildings."

Mr. Berg.—In acçordance with recommendations contained in the president's annual address, I desire to offer the following resolu tion: "The chairmen of all committees, on subjects for investiga-

tion, are requested to present their reports to the secretary, not less than one month prior to holding of annual convention, and that the secretary be directed to have printed copies of said reports ready for distribution to the members and to the technical press on the first day of the convention." I do not think it will be necessary to speak for the motion, which explains itself. Seconded by Mr. Stannard. Carried.

Mr. Wallace.—Now that it has been defined that this is a bridge association, I would suggest that we define what the duties of a bridge superintendent are—whether confined to bridges or not.

Mr. Andrews.—I will state for the benefit of Mr. Wallace, and I believe the members will bear me out, that this association is composed of members who have charge of buildings and bridges on various railroads, some in the chief engineer's, and others in the maintenance of way departments, and in that department it is part of the duty to maintain water-stations, signals, and many other things which it would be folly for us to undertake to define; and that the title there [pointing to the banner] covers the entire ground; and that no member will offer for discussion a subject with which he has nothing to do. I think the members will bear me out on the question.

Reading and discussion of questions propounded by members, under which head come the reports on which the committees have been working the past year.

No. 1.—Mechanical action and resultant effects of motive power at high speed on bridges; G. W. Andrews, B. & O. R. R.; W. G. Berg, Lehigh Valley; J. E. Greiner, B. & O. R. R.; E. H. R. Green, Texas Midland.

Mr. Andrews.—This is a question of great importance to all railroads, and it is one that should not be hurried through. The majority of the members of the committee have worked hard during the year, in gathering data for the compilation of the report; and we found that it would also be necessary to design an instrument for taking the action of locomotives on bridges. One of our committee, Mr. J. E. Greiner, has been at work upon an instrument of this kind for the past several months, but has been unable to complete it, owing to the immense amount of business that he has been compelled to attend to. I will state that I fully believe that this report will be ready at our next annual convention,

but it was utterly impossible to present it at this, and I would now therefore report progress.

Moved and seconded that the report of the committee be received, and that they be granted another year in which to prepare full report. Carried.

No. 2.—Postponed to afternoon session.

No. 3.—Strength of various kinds of timbers used in trestles and bridges, especially with reference to southern yellow pine, white pine, fir, and oak; W. G. Berg, Lehigh Valley; J. H. Cummin, Long Island; John Foreman, P. & R. R. R.; H. L. Fry, C. F. & Y. V.

Mr. Cummin.—As one of the members of that committee, before the chairman reads the report, I would like to say a few words in regard to the report of the committee. It reminds me, in some respects, of a story told me some years ago by an old Methodist minister, concerning two deacons of the church, whom he said agreed better than any two he had ever met, for the reason that one of them was willing to do all the work and the other was willing to let him do it. The same thing has happened in the report of this committee; the chairman was perfectly willing to do all the work, and, from my own experience and what I have heard from the other members, they were perfectly willing to let him, but I feel sure that the members of this association will all agree with me when they have had an opportunity of hearing the report in full. To use an old stereotyped phrase, the midnight oil must have burned for weeks in the preparation of this report, and I deem this statement but justice to the chairman of our committee.

Mr. Berg.—I desire to thank Mr. Cummin for his kind and appreciative remarks on what I have done; but in order to enable the members to get the full value of the report,—in other words, that it may not be understood that the report is based solely on my experience,—I beg to say that from the nature of this report and the way in which it had to be prepared, one man was properly forced to do the work; the other members of the committee, however, examined the report very carefully, and have all endorsed the results shown therein, so that it is in reality the report of the full committee.

Reading of report by Mr. Berg.

REPORT OF COMMITTEE ON "STRENGTH OF BRIDGE AND TRESTLE TIMBERS."

Your committee appointed to report on "Strength of Bridge and Trestle Timbers, with special reference to Southern Yellow Pine, White Pine, Fir, and Oak," desire to present herewith, as part of their report, the very valuable data compiled by the chairman of the committee, relative to tests of the principal American bridge and trestle timbers and the recommendations of the leading authorities on the subject of strength of timber during the last twenty-five years, embodied in the appendix to this report and tabulated for easy reference in the accompanying tables I to IV.

The uncertainty of our knowledge relative to the strength of timber is clearly demonstrated after a perusal of this information, and emphasizes, better than long dissertations on the subject, the necessity for more extensive, thorough, and reliable series of tests, conducted on a truly scientific basis, approximating, as nearly as possible, actual conditions encountered in practice.

The wide range of values recommended by the various recognized authorities is to be regretted, especially so when undue influence has been attributed by them in their deductions to isolated tests of small size specimens, not only limited in number, but especially defective in not having noted and recorded properly the exact species of each specimen tested, its origin, condition, quality, degree of seasoning, method of testing, etc.

The fact has been proved beyond dispute that small size specimen tests give much larger average results than full size tests, owing to the greater freedom of small selected test pieces from blemishes and imperfections and their being, as a rule, comparatively drier and better seasoned than full size sticks. The exact increase, as shown by tests and by statements of different authorities, is from ten to over one hundred per cent.

Great credit is due to such investigators and experimenters as Professors G. Lanza, J. B. Johnson, H. T. Bovey, C. B. Wing, and Messrs. Onward Bates, W. H. Finley, C. B. Talbot, and others, for their experimental work and agitation in favor of full size tests. Professors G. Lanza, R. H. Thurston, and William H. Burr have contributed valuable treatises on the subject of strength of timber. The extensive series of small and full size United States government tests, conducted in 1880 to 1882, at the Watertown arsenal, under Col. T. T. S. Laidley, and more recently the very elaborate and thorough timber-tests being conducted by the United States Forestry Division under Dr. B. E. Fernow, chief, and Professor J. B. Johnson of Washington University, St. Louis, afford us to-day, in connection with the work of the above-mentioned experimenters, our most reliable data from a practical standpoint.

The test data at hand and the summary criticisms of leading authorities seem to indicate the general correctness of the following conclusions:

1. Of all structural materials used for bridges and trestles timber is the most variable as to the properties and strength of different pieces classed as belonging to the same species, hence impossible to establish close and reliable limits of strength for each species.

2. The various names applied to one and the same species in different parts of the country lead to great confusion in classifying or applying results of tests.

3. Variations in strength are generally directly proportional to the density or weight of timber.

4. As a rule, a reduction of moisture is accompanied by an increase in strength; in other words, seasoned lumber is stronger than green lumber.

5. Structures should be in general designed for the strength of green or moderately seasoned lumber of average quality and not for a high grade of well-seasoned material.

6. Age or use do not destroy the strength of timber, unless decay or season-checking takes place.

7. Timber, unlike materials of a more homogeneous nature, as iron and steel, has no well defined limit of elasticity. As a rule, it can be strained very near to the breaking point without serious injury, which accounts for the continuous use of many timber structures with the material strained far beyond the usually accepted safe limits. On the other hand, sudden and frequently inexplicable failures of individual sticks at very low limits are liable to occur.

8. Knots, even when sound and tight, are one of the most objectionable features of timber, both for beams and struts. The full size tests of every experimenter have demonstrated, not only that beams break at knots, but that invariably timber struts will fail at a knot or owing to the proximity of a knot, by reducing the effective area of the stick and causing curly and cross-grained fibers, thus exploding the old practical view that sound and tight knots are not detrimental to timber in compression.

9. Excepting in top logs of a tree or very small and young timber, the heart-wood is, as a rule, not as strong as the material farther away from the heart. This becomes more generally apparent, in practice, in large sticks with considerable heart-wood cut from old trees in which the heart has begun to decay or been wind-shaken. Beams cut from such material frequently season-check along middle of beam and fail by longitudinal shearing.

10. Top logs are not as strong as butt logs, provided the latter have sound timber.

11. The results of compression tests are more uniform and vary less for one species of timber than any other kind of test; hence, if only one kind of test can be made, it would seem that a compressive test will furnish the most reliable comparative results.

12. Long timber columns generally fail by lateral deflection or "buckling" when the length exceeds the least cross-sectional dimension of the stick by twenty, in other words, the column is longer than twenty diameters. In practice the unit stress for all columns over fifteen diameters should be reduced in accordance with the various rules and formulæ established for long columns.

13. Uneven end-bearings and eccentric loading of columns produce more serious disturbances than usually assumed.

14. The tests of full-size, long, compound columns, composed of several sticks bolted and fastened together at intervals, show essentially the same ultimate unit resistance for the compound column as each component stick would have if considered as a column by itself.

15. More attention should be given in practice to the proper proportioning of bearing areas; in other words, the compressive bearing resistance of timber with and across grain, especially the latter, owing to the tendency of an excessive crushing stress across grain to indent the timber, thereby destroying the fiber and increasing the liability to speedy decay, especially when exposed to the weather and the continual working produced by moving loads.

The aim of your committee has been to examine the conflicting test data at hand, attributing the proper degree of importance to the vari-

ous results and recommendations, and then to establish a set of units that can be accepted as fair average values, as far as known to-day, for the ordinary quality of each species of timber and corresponding to the usual conditions and sizes of timbers encountered in practice. The difficulties of executing such a task successfully cannot be overrated, owing to the meagreness and frequently the indefiniteness of the available test data, and especially the great range of physical properties in different sticks of the same general species, not only due to the locality where it is grown, but also to the condition of the timber as regards the percentage of moisture, degree of seasoning, physical characteristics, grain, texture, proportion of hard and soft fibers, presence of knots, etc., all of which affect the question of strength.

Your committee recommends, upon the basis of the test data at hand at the present time, the average units for the ultimate breaking stresses of the principal timbers used in bridge and trestle constructions shown in the accompanying table.

In addition to the units given in the table, attention should be called to the latest formulæ for long timber columns, mentioned more particularly in the Appendix to this report, which formulæ are based upon the results of the more recent full-size timber column tests, and hence should be considered more valuable than the older formulæ derived from a limited number of small-size tests. These new formulæ are Professor Burr's, App. I.; Professor Ely's, App. J.; Professor Stanwood's, App. K., and A. L. Johnson's, App. V.; while C. Shaler Smith's formulæ will be better understood after examining the explanatory notes contained in App. L.

Attention should also be called to the necessity of examining the resistance of a beam to longitudinal shearing along the neutral axis, as beams under transverse loading frequently fail by longitudinal shearing in place of transverse rupture.

In addition to the ultimate breaking unit stress the designer of a timber structure has to establish the safe allowable unit stress for the species of timber to be used. This will vary for each particular class of structures and individual conditions. The selection of the proper "factor of safety" is largely a question of personal judgment and experience, and offers the best opportunity for the display of analytical and practical ability on the part of the designer. It is difficult to give specific rules. The following are some of the controlling questions to be considered:

The class of structure, whether temporary or permanent, and the nature of the loading, whether dead or live. If live, then whether the application of the load is accompanied by severe dynamic shocks and pounding of the structure. Whether the assumed loading for calculations is the absolute maximum rarely to be applied in practice, or a possibility that may frequently take place. Prolonged heavy, steady loading, and also alternate tensile and compressive stresses in the same piece, will call for lower averages. Information as to whether the assumed breaking stresses are based on full-size or small-size tests, or only on interpolated values averaged from tests of similar species of timber, is valuable, in order to attribute the proper degree of importance to recommended average values. The class of timber to be used, and its condition and quality. Finally, the particular kind of strain the stick is to be subjected to, and its position in the structure with regard to its importance and the possible damage that might be caused by its failure.

In order to present something definite on this subject, your committee presents the accompanying table showing the average safe allowable working unit stresses for the principal bridge and trestle timbers, prepared to meet the average conditions existing in railroad

timber structures, the units being based upon the ultimate breaking unit stresses recommended by your committee and the following factors of safety, viz.:

Tension, with and across grain	10
Compression, with grain	5
Compression, across grain	4
Transverse, extreme fiber stress	6
Transverse, modulus of elasticity	2
Shearing, with and across grain	4

In conclusion, your committee desires to emphasize the importance and great value to the railroad companies of the country of the experimental work on the strength of American timbers being conducted by the Forestry Division of the United States Department of Agriculture, and to suggest that the American Association of Railway Superintendents of Bridges and Buildings endorse this view by official action, and lend its aid in every way possible to encourage the vigorous continuance of this series of government tests, which bids fair to become the most reliable and useful work on the subject of strength of American timbers ever undertaken. With additional and reliable information on this subject, far-reaching economies in the designing of timber structures can be introduced, resulting not only in a great pecuniary saving to the railroad companies, but also offering a partial check to the enormous consumption of timber and the gradual diminution of our structural timber supply.

WALTER G. BERG, *Chairman,*
J. H. CUMMIN,
JOHN FOREMAN,
H. L. FRY,

Committee.

AVERAGE ULTIMATE BREAKING UNIT STRESSES, IN POUNDS, PER SQUARE INCH.

RECOMMENDED BY THE COMMITTEE ON "STRENGTH OF BRIDGE AND TRESTLE TIMBERS."

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.
FIFTH ANNUAL CONVENTION, NEW ORLEANS, OCTOBER, 1895.

KIND OF TIMBER.	Tension		Compression.			Transverse.		Shearing.	
	With Grain.	Across Grain.	With Grain. End bearing.	With Grain. Columns under 15 diams.		Extreme fiber stress.	Modulus of Elasticity.	With Grain.	Across. Grain.
......	10,000	2,000	7,000	4,500	2,000	6,000	1,100,000	800	4,000
......	7,000	500	5,500	3,500	800	4,000	1,000,000	400	2,000
pine	12,000	600	8,000	5,000	1,400	7,000	1,700,000	600	5,000
......	12,000	....	8,000	6,000	1,200	6,500	1,400,000	600	....
......	10,000	....	....	....	....	5,000	....	....	....
......	9,000	500	6,000	4,000	1,000	6,000	1,200,000	400	4,000
......	9,000	500	6,000	4,000	800	5,000	1,200,000	....	....
......	8,000	....	6,000	4,000	800	4,000	1,200,000	....	....
......	10,000	....	....	5,000	....	....	....	350	....
[illegible]	10,000	....	....	5,000	....	5,000	1,400,000	400	....
Spruce and Eastern fir	8,000	500	6,000	4,000	700	4,000	1,200,000	400	3,000
Hemlock	6,000	....	....	4,000	600	3,500	900,000	350	2,500
Cypress	6,000	....	6,000	4,000	700	5,000	900,000	....	....
Cedar	8,000	....	6,000	4,000	700	5,000	700,000	....	1,500
Chestnut	9,000	....	....	5,000	900	5,000	1,000,000	600	1,500
California redwood	7,000	....	....	4,000	800	4,500	700,000	400	....
California spruce	....	....	....	4,000	....	5,000	1,200,000	....	....

AVERAGE SAFE ALLOWABLE WORKING UNIT STRESSES, IN POUNDS, PER SQUARE INCH.

RECOMMENDED BY THE COMMITTEE ON "STRENGTH OF BRIDGE AND TRESTLE TIMBERS."

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.
FIFTH ANNUAL CONVENTION, NEW ORLEANS, OCTOBER, 1895.

KIND OF TIMBER.	Tension.		Compression.			Transverse.		Shearing.	
	With Grain.	Across Grain.	With Grain. End bearing.	With Grain. Columns under 15 diams.	Across Grain.	Extreme fiber stress.	Modulus of elasticity.	With Grain.	Across Grain.
Factor of Safety.	Ten.	Ten.	Five.	Five.	Four.	Six.	Two.	Four.	Four.
White oak	1,000	200	1,400	900	500	1,000	550,000	200	1,000
	700	50	1,100	700	200	700	600,000	100	500
ia yellow pine	1,200	60	1,600	1,000	350	1,200	850,000	150	1,250
ow fir	1,200		1,600	1 200	300	1,100	700,000	150	
fir	1,000					800			
r pine	900	50	1,200	800	250	1,000	600,000	100	1,000
	900	50	1,200	800	200	800	600,000		
	800		1,200	800	200	700	600,000		
	1,000			1,000				100	
Canadian (Ontario) red pine	1,000			1,000		800	700,000	100	
Spruce and Eastern fir	800	50	1,200	800	200	700	600,000	100	750
Hemlock	600			800	150	600	450,000	100	600
Cypress	600		1,200	800	200	800	450,000		
Cedar	800		1,200	800	200	800	350,000		400
Chestnut	900			1,000	250	800	500,000	150	400
California redwood	700			800	200	750	350,000	100	
California spruce				800		800	600,000		

TABLE 1.—

ULTIMATE BREAKING STRESS, IN

Compiled for the Fifth Annual Convention of the Association of

Group	Authority.	Appendix reference.	Description.	Tension. With Grain. Limits.	Tension. With Grain. Av.	Tension. Across Grain. Lim.	Tension. Across Grain. Av.
Recommended Values.	W. J. M. Rankine	A	Red oak		10,250		
			English oak	10,000-19,800			
	Chas. H. Haswell	A	Oak				2,300
			White oak		16,500		
			Live oak		16,380		
			Canadian white oak				
			Red oak		10,250		
			Pennsylvania oak, seasoned		20,333		
	John C. Trautwine	A	Oak				2,300
			White oak		10,000		
			Live oak		10,000		
			Basket, black, and red oak		10,000		
	Robert H. Thurston	A	Oak				
			White oak		10,000		
			Live oak		10,000		
			Canadian oak				
	Louis DeC. Berg	A	White oak		11,000		2,300
			Red oak		8,000		
			Live oak		11,000		
			Canadian oak		7,500		
	F. E. Kidder	A	White oak		16,000		
	Malverd A. Howe	A	White oak		10,000		
			Live oak		10,000		
	William Kent	A	Oak				
	A. L. Johnson	W	White oak		10,000		
Results of Small Size Tests.	U. S. Ordnance Depar't, Capt. T. J. Rodman	B. i.	White oak, well seasoned	13,333-25,222			
	Thomas Laslett	B. b.	White oak		7,021		
			Baltimore oak		8,832		
	R. G. Hatfield	B. a.	Oaks, average				
			White oak		19,500		
			Canadian oak				
			Live oak				
	U. S. 10th Census	B. h.	White oak				
			White, post, iron, red, and black oak				
			Scrub and basket oak				
			Chestnut and live oak				
			Pin oak				
	Robert H. Thurston	B. c.	White oak		18,210		
			Live oak		10,310		
	St. Louis Bridge	B. d.	White oak, blocks				
			White oak, round columns				
			Black oak, blocks				
			Black oak, round columns				
	U. S. Ordnance Depar't, Watertown Arsenal	B. f.	White oak	12,670-22,703	17,410		
			Red oak	7,600-12,183	10,124		
			Yellow oak	20,260-20,520	20,390		
Results of Full Size Tests.	G. Lanza	D. c.	White oak, 36 beams				
		G. a.	White oak, 10 posts and blocks				
		G. a.	White oak, 18 old posts				
	D. Kirkaldy & Son	E. b.	White oak, 5 beams, 5 feet span				
			White oak, 5 beams, 11 feet span				
			White oak, 5 posts, about 6 diams				
			White oak, 5 posts, about 11 diams				
			White oak, 5 posts, about 23 diams				

AND TRESTLE TIMBERS.

OAK.

POUNDS, PER SQUARE INCH.

RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS, OCTOBER, 1895, BY WALTER G. BERG.

Compression.					Transverse.				Shearing.			
With Grain.		Across Grain.			Extreme Fiber Stress.		Modulus of Elasticity.		With Grain.		Across Grain.	
Limits.	Av.	Limits.	Indentation.	Av.	Limits.	Av.	Limits.	Av.	Limits.	Av.	Lim.	Av.
	6,000					10,600		2,150,000				
	10,000				10,000-13,600		1,200,000-1,750,000			2,300		4,000
				2,300				1,710,000		780		4,032
	7,500					10,800						
	6,850					11,520						
	5,982					10,512						
						9,720						
5,000-7,000	6,000						1,000,000-2,000,000	1,500,000	400-700			
						10,800						4,425
						10,800						8,480
						15,800						
										780		4,000
5,500-8,000						11,000						
8,000-10,000						12,000						
						10,000						
	7,200			2,400		7,200		900,000		800		4,400
	6,000					6,500		1,200,000		750		
	6,850			4,500		7,300				700		8,500
	6,000					7,000						
3,150-7,000						5,670		1,240,000		780		4,400
	7,000		1-10 in.	1,600				1,500,000		850		4,400
	7,000		1-10 "	1,600				1,500,000				
							974,000-2,283,000					
	4,000		3 pr ct.	1,200		6,000		1,100,000		800		
4,691-10,058					8,460-17,340							
	6,964					10,900		1,330,000				
	5,891					9,800		1,770,000				
						8,550		1,114,560				
6,581-9,775	8,000		1-20 in.	2,650		11,700		1,339,200	1,076-1,474	1,250		
						10,600		1,929,812				
	11,100		1-20 "	6,800								
5,810-9,070			1-100 "	1,600	7,010-18,360		879,000-2,103,000					
			1-10 "	4,000								
	7,000		1-10 "	4,000								
	6,000		1-10 "	4,200								
	7,500		1-10 "	4,500								
	6,500		1-10 "	8,000								
	7,140					9,840		1,620,000				
	10,410					11,280		1,851,428				
3,200-3,778	3,505	1,300-2,200		1,750								
6,000-12,200	7,812											
		1,600-2,000		1,800								
5,400-6,980	6,101											
	7,192		1-20 "	2,850						842		
										803		
					3,535-7,834	5,868	744,774-1,777,500	1,131,100				
3,132-4,450	3,470											
2,948-6,147	3,957											
						6,890						
						8,550						
	3,285											
	3,418											
	2,891											

STRENGTH OF BRIDGE

TABLE 2.—

ULTIMATE BREAKING STRESS, IN

COMPILED FOR THE FIFTH ANNUAL CONVENTION OF THE ASSOCIATION OF

	AUTHORITY.	Appendix reference.	DESCRIPTION.	Tension.			
				With Grain.		Across Grain.	
				Limits.	Av.	Lim.	Av.
Recommended Values.	Chas. H. Haswell	A	White pine		11,800		550
	John C. Trautwine	A	White pine		10,000		550
	Robert H. Thurston	A	White pine	8,000–7,500			
	Louis DeC. Berg	A	White pine		9,000		550
	F. E. Kidder	A	White pine		7,000		
	Malverd A. Howe	A	White pine		10,000		
	H. T. Bovey	M	Canadian (Ottawa) white pine				
	A. L. Johnson	W	White pine		7 000		
	W. M. Patton	A	White pine		7,000		
Results of Small Size Tests.	U. S. Ordnance Depar't, Capt. T. J. Rodman	B. i.	White pine, well seasoned	11,433–11,960			
	R. G. Hatfield	B. a.	White pine		12,000		
	U. S. 10th Census	B. h.	White pine				
	Robert H. Thurston	B. c.	White pine		6,880		
	St. Louis Bridge	B. d.	White pine, blocks				
			White pine, columns				
	F. E. Kidder	B. e.	White pine				
	U. S. Ordnance Depar't, Watertown Arsenal	B. f.	White pine	5,800–11,299	8,916		
		Q	White pine, resistance to keys tearing out				
	H. T. Bovey	M	Canadian (Ottawa) white pine	8,503–14,273	11,396		
Results of Full Size Tests.	H. T. Bovey	M. I.	Canadian (Ottawa) white pine, 15 beams				
		M. II.	Canadian (Ottawa) white pine, 68 posts				
	U. S. Ordnance Depar't, Watertown Arsenal	H. a.	White pine, posts, under 32 dia.				
			White pine, posts 32–62 diams				
	G. Lanza	D. d.	White pine, 37 beams				
			Western white pine, kiln dried, 8 beams				
	Onward Bates	R. a.	White pine, new and old, 30 b'ms				
		R. b.	White pine, new, 14 beams				
	W. H. Finley	S	White pine, 31 years in use, 12 beams				
			White pine, new, 2 beams				

AND TRESTLE TIMBERS.

WHITE PINE.

POUNDS, PER SQUARE INCH.

RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS, OCTOBER, 1895, BY WALTER G. BERG.

COMPRESSION.					TRANVERSE.				SHEARING.			
With Grain.		Across Grain.			Extreme Fiber Stress.		Modulus of Elasticity.		With Grain.		Across Grain.	
Limits.	Av.	Lim.	Indentation.	Av.	Limits.	Av.	Limits.	Av.	Lim.	Av.	Lim.	Av.
....	5,775	......	......	550	....	9,000	....	1,830,000	......	490	......	....
5,000-7,000	6,000	......	......	....	....	8,100	....	1,600,000	250-500	....	......	2,480
3,000-6,000	....	......	......	....	....	....	....	1,000,000	......	490	......	....
....	5,500	......	......	700	....	4,000	....	850,000	......	450	......	2,500
2,800-4,500	....	......	......	....	....	4,320	....	1,073,000	......	490	......	2,480
....	5,400	......	1-10 in.	600	....	....	....	1,750,000	......	325	......	2,480
....	5,000	......	......	....	....	....	....	....	......	....	......	....
....	3,500	......	3 pr ct.	440	....	4,400	....	870,000	......	300	......	....
....	9,500	......	......	....	....	9,000	....	....	......	482	......	2,480
5,017-5,775	....	......	......	....	6,798-7,092	....	....	....	......	....	......	....
5,579-7,502	6,650	......	1-20 in.	800	....	9,000	....	1,252,800	433-580	480	......	....
3,750-5,600	5,400	......	1-100 " 1-10 "	600 1,200	5,610-11,530	....	868,000-1,478,000	....	......	....	......	....
....	9,590	......	......	....	....	5,280	....	883,636	......	....	......	....
3,083-3,694	3,261	555-722	......	611	....	....	....	....	......	....	......	....
3,580-3,900	3,727	......	......	....	....	....	....	....	......	....	......	....
....	....	......	......	....	7,578-9,440	8,297	1,251,252-1,461,728	1,888,497	......	....	......	....
....	5,617	......	1-20 "	1,045	....	....	....	....	......	370	......	....
....	....	......	......	....	....	....	....	....	236-611	421	......	....
....	....	......	......	....	....	....	....	....	273-382	....	......	....
....	....	......	......	....	2,500-4,936	3,388	433,250-1,184,240	754,265	......	....	......	....
....	3,848	......	......	....	....	....	....	....	......	....	......	....
1,687-3,700	2,414	......	......	....	....	....	....	....	......	....	......	....
1,000-2,000	....	......	......	....	....	....	....	....	......	....	......	....
....	....	......	......	....	2,456-7,251	4,451	727,200-1,565,000	1,122,000	......	....	......	....
....	....	......	......	....	....	5,482	....	1,183,037	......	....	......	....
....	....	......	......	....	2,850-5,376	3,872	712,500-1,430,900	1,096,000	......	....	......	....
....	....	......	......	....	2,160-5,131	3,694	....	....	......	....	......	....
....	....	......	......	....	5,139-10,616	7,051	715,000-1,900,000	1,208,250	......	....	......	....
....	....	......	......	....	....	5,402	....	982,500	......	....	......	....

TABLE 3.—SOUTHERN YELLOW PINE, LONG-LEAF YELLOW

ULTIMATE BREAKING STRESS, IN

COMPILED FOR THE FIFTH ANNUAL CONVENTION OF THE ASSOCIATION OF RAIL-

	AUTHORITY.	Appendix reference.	DESCRIPTION.	TENSION.			
				With Grain.		Across Grain.	
				Limits.	Av.	Lim.	Av.
RECOMMENDED VALUES.	W. J. M. Rankine	A	Yellow pine				
	Chas H. Haswell	A	Pitch pine				550
			Yellow pine		18,000		550
			Virginia pine		19,200		550
			Georgia pine				550
	John C. Trautwine	A	Yellow pine		10,000		550
			Georgia yellow pine				
			Pitch pine		10,000		
	Robert H. Thurston	A	Yellow pine	5,000–12,000			
			Pitch pine	8,000–10,000			
	Louis DeC. Berg	A.	Yellow pine		9,000		
			Georgia yellow pine		12,000		
			Pitch pine		10,000		
	F. E. Kidder	A	Yellow pine		16,000		
	Malverd A. Howe	A	Southern yellow pine		10,000		
	G. Lanza	D. b.	Yellow pine				
	A. L. Johnson	W	Long-leaf pine		12,000		
	W. M. Patton	A	Yellow pine		20,700		
RESULTS OF SMALL SIZE TESTS.	U. S. Ordnance Depar't, Capt. T. J. Rodman	B. i.	Yellow pine, well seasoned	12,600–19,200			
	Thomas Laslett	B. b.	Pitch pine		4,666		
	R. G. Hatfield	B. a.	Georgia pine		16,000		
			Pitch pine				
	U. S. 10th Census	B. h.	Long-leaf Georgia pine				
	Robert H. Thurston	B. c.	Yellow pine		20,700		
	St Louis Bridge	B. d.	Yellow pine, blocks				
			Yellow pine, columns				
	F. E. Kidder	B. e.	Yellow pine				
	U. S. Ordnance Depar't,	B. f.	Yellow pine	12,066-17,922	15,478		
	Watertown Arsenal	Q.	Yellow pine, resistance to keys tear'g out				
	U. S. Forestry Departm't, Bulletin No. 8	C	Long-leaf pine, from Alabama	4,170–31,890	16,029		
RESULTS OF FULL SIZE TESTS.	U. S. Forestry Departm't, Bulletin No. 8	C	Long-leaf pine, from Alabama				
	G. Lanza	D. b.	Yellow pine, 51 beams				
		G. a.	Yellow pine, 18 posts and blocks				
	U. S. Ordnance Depar't,	H. a.	Yellow pine, posts under 22 diams				
	Watertown Arsenal	H. a.	Yellow pine, posts 22 to 62 diams				
		H. c.	Yellow pine, straight grain, well seasoned, 12 posts				
			Yellow pine, very slow growth, 3 posts				
			Yellow pine, very green and wet, 3 posts				

AND TRESTLE TIMBERS.

PINE, GEORGIA YELLOW PINE, AND SOUTHERN PITCH PINE.

POUNDS, PER SQUARE INCH.

WAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS, OCTOBER, 1895, BY WALTER G. BERG.

Compression.					Transverse.				Shearing.			
With Grain.		Across Grain.			Extreme Fiber Stress.		Modulus of Elasticity.		With Grain.		Across Grain.	
Limits.	Av.	Limits.	Indentation.	Av.	Limits.	Av.	Limits.	Av.	Lim.	Av.	Lim.	Av.
	5,400											
	8,947			550		9,864		2,430,000		510		
				550		9,360						
	8,200			550								
				550		14,400						
						9,000		1,600,000			4,840–5,735	
						15,300						5,735
						9,900						5,058
6,500-10,000						7,000		1,600,000		510		
						8,000		1,900,000				
	5,400					6,000		1,100,000				4,800
	7,400			1,850		7,200		1,200,000		500		5,700
	8,900					6,600		1,225,000		510		5,000
4,400–6,000						6,750		1,780,000		510		5,700
	8,500		1-10in	1,300				1,600,000		325		5,700
						5,000						
	5,000		3 p. c.	645		7,750		1,440,000		500		
	11,500					15,000				843		5,735
7,886–8,350					8,796–11,676	9,972						
	6,462					11,900		1,900,000				
8,170-11,503	9,500		1-20in	2,250	9,000–21,168	15,300		2,468,800	713–934	840		
						9,792		1,225,152				
4,010-10,600	8,500		1-100 1-10 "	1,300 2,600	9,220-21,060		879,000–2,878,000					
	11,950					16,740		3,534,727				
4,500–4,917	4,722	1,000-1,222		1,092								
4,650–4,820	4,735											
					12,280–14,654	18,048	1,707,282–1,926,160	1,821,680				
			1-20 "	1,900						352		
									337–720	512		
4,587–9,850	7,228	584–2,094	15p.c.	1,517					464–1,299	852		
					4,268–16,200	12,250	842,000–3,117,870	2,069,650				
					3,963–11,360	7,486	1,162,467–2,386,096	1,757,900				
3,604-5,452	4,544											
3,430–5,677	4,442											
1,700–3,500												
5,593–8,644	7,386											
7,820-10,250	9,339											
2,795–3,180	3,015											

TABLE 4.—DOUGLAS, OREGON, WASHINGTON,

ULTIMATE BREAKING STRESS, IN

COMPILED FOR THE FIFTH ANNUAL CONVENTION OF THE ASSOCIATION OF RAILWAY SUPER-

	AUTHORITY.	Appendix reference.	DESCRIPTION.	Tension. With Grain. Limits.	Tension. With Grain. Av.	Tension. Across Grain. Lim.	Tension. Across Grain. Av.
RECOMMENDED VALUES.	Robert H. Thurston	A	Oregon pine	9,000-14,000			
			California spruce	12,000-14,000			
	F. E. Kidder	A	Oregon pine		13,800		
			Oregon spruce				
	H. T. Bovey	M	Douglas fir				
			Douglas fir, specially selected				
			Douglas fir, ordinary first qual.				
	Arthur Brown, Southern Pacific Ry	O. b.	Pacific Northwest (Douglas) fir		15,900		
	A. L. Johnson	W	Douglas fir				
RESULTS OF SMALL SIZE TESTS.	U. S. Ordnance Depar't, Capt. T. J. Rodman	B. i.	Oregon yellow fir	13,633-16,833			
			Oregon red fir		12,867		
			Oregon white fir		14,583		
	U. S. 10th Census	B. h.	Red and yellow Douglas fir				
	W. B. Wright	O. d.	Red fir		10,872		
			Yellow fir		11,550		
	Oregon & California R.R.	O. e.	Douglas fir		16,600		
			Oregon sugar pine		11,000		
	Robert H. Thurston	O. c.	Oregon pine				
			California spruce				
	U. S. Ordnance Depar't, Watertown Arsenal	B. f.	Oregon pine		13,810		
			Oregon spruce		16,160		
	A. T. Bovey	M. III	Douglas fir, 71 tests	2,485-18,856	11,612		
		M. IV	Douglas fir				
	John D. Isaacs, Southern Pacific Ry	T	Douglas fir		15,900		
RESULTS OF FULL SIZE TESTS.	Onward Bates	R. c.	Douglas fir, 12 beams				
			Douglas fir, 10 beams (omitting 2 bad sticks)				
	A. T. Bovey	M. I.	Douglas fir, specially selected, 4 beams				
		M. I.	Douglas fir, ordinary first quality, 15 beams				
		M. II.	Douglas fir, 122 posts				
		M. I.	British Colum. spruce, 3 beams				
		M. II.	British Colum. spruce, 69 posts				
	C. B. Talbot, Northern Pacific R. R	N. a.	Wash'n yel. fir, 5 small beams				
		N. e.	Washington fir, hard, fine grain, 1 small beam				
			Washington pine, fine grain, 1 small beam				
	A. J. Hart, Chic., Mil. & St. Paul R.R.	N. b.	Washington yellow fir, green, 4 beams				
			Washington yellow fir, 6 years seasoned, 2 beams				
	A. J. Hart & C. B. Talbot	N. c.	Washington fir, 9 beams				
	S. Kedzie Smith	N. d.	Washington yellow fir, close grain, 2 beams				
			Washington red fir, 8 beams				
		O. a.	Washington yellow and red fir, 19 beams				
	State of Washington Chapter, American Inst. Architects	N. f.	Douglas fir, 11 beams				
			Washington yel. fir, 13 beams				
			Washington red fir, 11 beams				
			Average of all tests				
	Charles B. Wing	U	Douglas fir, ordinary No. 1, merchantable, 10 beams				
			Douglas fir, ordinary No. 1, Merchantable, 10 small beams				

AND TRESTLE TIMBERS.

AND CALIFORNIA FIR, PINE, AND SPRUCE.

POUNDS, PER SQUARE INCH.

INTENDENTS OF BRIDGES AND BUILDINGS, OCTOBER, 1895, BY WALTER G. BERG.

Compression.					Transverse.				Shearing.			
With grain.		Across Grain.			Extreme Fiber Stress.		Modulus of Elasticity.		With Grain.		Across Grain.	
Limits.	Av.	Lim.	Indentation.	Av.	Limits.	Av.	Limits.	Av.	Lim.	Av.	Lim.	Av.
9,200-11,500						11,071						
9,200-12,800						12,228						
										840		
										810		
	6,000									400		
						9,000		2,000,000				
						6,000		1,430,000				
	6,000					13,630		1,272,000		600		
	4,400		3 per ct.	500		6,600		1,380,000				
7,488-9,217					7,740-10,944							
	7,083					6,728						
	6,644					4,194						
4,880-9,800					8,220-17,920		1,308,000-2,579,000					
	6,099					15,894						
	6,132					15,030						
	3,065		2-100 in.	1,000		8,658			515-833	689		
	3,391		4-100 "	1,000		8,370						
9,200-11,500						11,071						
9,200-12,800						12,228						
	8,597		1-20 "	1,150		17,223				786		
	5,772		1-20 "	695						811		
									377-411	403		
	6,000							1,272,000		600		
					3,597-7,544	5,791						
					5,268-7,544	6,214						
					8,020-10,441	9,054	1,934,500-2,178,100	2,036,529				
					4,027-8,382	6,081	926,500-1,770,563	1,431,209				
	5,974											
					4,614-5,908	5,120	1,011,450-1,528,499	1,203,633				
	3,617											
					6,890-9,720	7,847						
						9,720						
						5,116						
					6,143-7,982	7,823						
					5,985-6,088	6,020						
					5,268-7,561	6,278						
					7,500-8,160	7,830						
					4,255-6,138	5,186						
					3,580-8,160	5,420						
						5,979						
						7,402						
						5,186						
						6,859						
					5,580-7,951	6,482						
					6,438-12,056	9,257						

APPENDIX A.

EXPLANATORY OF TABLES SHOWING STRENGTH OF BRIDGE AND TRESTLE TIMBERS.

Tables 1 to 4.

These tables were compiled to show all the information available in regard to the strength of the principal American bridge and trestle timbers. The literature consulted covers the period since 1875 to date, and the endeavor has been to take into consideration all important test results or recommendations of eminent engineering authorities during that time.

Unless otherwise stated, the timbers mentioned are invariably to be considered as American. Considerable trouble is caused in a compilation of this kind to classify the results properly, owing to the different and also the indefinite names used by the various authors and engineers in describing the species of wood tested or referred to.

The explanatory data for the small-size tests, mentioned in the tables, are recorded in Appendix "B," while the full-size and very valuable tests are given in considerable detail in special articles under the various headings of the Appendix.

The average values for strength of timbers recommended by different authorities, as given in the tables, are of interest as showing the results of the studies and researches of these parties. While a great many of the unit values given are merely the work of compilation from the best available data and in many cases clearly copied from previous publications, still a great many of the results are from individual experience or unpublished tests. At any rate, each author has carefully sifted the information at his command, correcting and adjusting it according to his best abillity.

Below will be found a few notes in regard to the professional standing of the authors consulted.

Prof. W. J. M. Rankine, the celebrated English engineering authority and experimenter on strength of timber, author of "Applied Mechanics," "Manual of Engineering," etc.

Prof. Robert H. Thurston, Cornell University, Ithaca, N. Y. (formerly Stevens Institute of Technology, Hoboken, N. J.), author of "Materials of Engineering," "Materials of Construction," and numerous technical books; writer and experimenter on strength of timber.

John C. Trautwine, civil engineer, author of "Trautwine's Civil Engineer's Pocket-Book;" writer and experimenter on strength of timber.

F. E. Kidder, civil engineer and architect, Denver, Col., author of "Kidder's Architects and Builders' Pocket-Book;" writer and experimenter on strength of timber.

Louis De C. Berg, architect, New York city, member American Society Civil Engineers, author of "Safe Building."

A. L. Johnson, civil engineer, in charge of U. S. Forestry Division physical timber tests under the direction of Prof. J. B. Johnson, Washington University, St. Louis, Mo.

Prof. Malverd A. Howe, Rose Polytechnic Institute, Terre Haute, Ind.

Prof. Gaetano Lanza, Massachusetts Institute of Technology, Boston, Mass., well known writer and experimenter on the strength of timber, author of "Applied Mechanics."

William Kent, mechanical engineer, New York city, author of "Kent's Mechanical Engineer's Pocket-Book," associate editor of *Engineering News*; well known writer and compiler of experimental statistics.

Prof. Wm. H. Burr, Columbia College, New York city, author of "The Elasticity and Resistance of the Materials of Engineering."

R. G. Hatfield, architect, New York city, author of "Transverse Strains" (1877), and "American House Carpenter;" experimenter on strength of timber.

Thomas Laslett, English writer and experimenter on strength of timber, author of "Timber and Timber Trees" (1875).

Col. T. T. S. Laidley, in charge U. S. Ordnance Department timber tests, Watertown arsenal, 1880 and 1881, (Ex. Doc. No. 12, 47th congress, 1st session, and Ex. Doc. No. 1, 47th congress, 2d session).

Capt. T. J. Rodman, in charge U. S. Army Department timber tests, published in the "Ordnance Manual."

T. P. Sharples, in charge of American timber tests for tenth census, 1880, published in Vol. IX., on the "Forests of North America;" also in tests of materials, U. S. Ordnance Department, 1883, Ex. Doc. No. 5, 48th congress, 1st session, summary, page 568.

Prof. Henry T. Bovey, McGill University, Montreal, Canada, writer and experimenter on strength of Canadian timbers.

Charles H. Haswell, author of Haswell's "Mechanics and Engineers' Pocket-Book."

W. M. Patton, professor of civil engineering in Virginia, and author of a "Treatise on Civil Engineering."

APPENDIX B.

RECORD OF TIMBER TESTS WITH SMALL SPECIMENS.

(*a*) Hatfield's tests ("Transverse Strains," 1877) have been widely quoted and utilized. Unfortunately the tests were all made on unusually small specimens, and hence much higher results than corresponding full-size tests show.

Tensile tests, specimens about one third inch in diameter.

Compressive tests, nine tests of each kind of timber, specimens one to two diameters high.

Shearing tests, nine tests of each kind of timber, specimens small.

Transverse tests, specimens one inch square, short spans.

(*b*) Laslett's tests of English and foreign timbers ("Timber and Timber Trees," 1875; revised edition, 1894).

Tensile tests, specimens two inches square.

Compressive tests, small cubes one to four inches in size.

Transverse tests, specimens two inches square and six feet span.

(*c*) Professor Thurston's small-size tests (*Journal Franklin Institute*, October, 1879, and September, 1880).

Tensile tests, specimens one half inch in diameter.

Compressive tests, specimens about one and one eighth inches in diameter and two and one fourth inches long.

Transverse tests, specimens three inches square and four and one half feet span.

(*d*) St. Louis bridge tests made during construction of bridge. All timber well-seasoned excepting the white oak.

Compressive tests on blocks with and across grain, cubes three to six inches in size, two to four tests of each kind. Compressive tests on round columns, about two and one fourth inches in diameter, and from two to twenty-four inches long; as a rule, length about thirteen inches or six diameters; none of the columns over eleven diameters.

(*e*) F. E. Kidder's small-size transverse tests (*Van Nostrand's Magazine*, February, 1880); five yellow pine specimens, about one and one fourth inch square, and eight white pine specimens, about one and one half inch square, all on supports forty inches apart. Very well seasoned timber of excellent quality.

(*f*) U. S. Ordnance Department small-size tests, Watertown arsenal, Col. T. T. S. Laidley.
Tensile tests, specimens generally about one inch in diameter.
Compressive tests with and across grain, specimens small size.
Compression across grain taken as the force producing an indentation of one twentieth inch.
Transverse tests, well-seasoned sticks, from one and one fourth inch to four inches square, and spans of twenty-two to forty-four inches.
Shearing tests, small specimens.

(*g*) John C. Trautwine, some small-size tests for shearing across grain (*Journal of the Franklin Institute*, February, 1880), valuable as representing shearing values for small, round, wooden tree nails and pins.
These shearing tests, specimens five eighths inch round, gave the following values for the ultimate breaking, shearing stress across grain in pounds per square inch:

Ash	6,280	Locust	7,176
Beech	5,223	Maple	6,355
Birch	5,595	White oak	4,425
White cedar	1,372 to 1,519	Live oak	8,480
Central American cedar	3,410	White pine	2,480
Cherry	2,945	Northern yellow pine	4,340
Chestnut	1,535	Southern yellow pine	5,735
Dogwood	6,510	Yellow pine, very resinous	5,053
Ebony	7,750	Poplar	4,418
Gum	5,890	Spruce	3,255
Hemlock	2,750	Black walnut	4,728
Hickory	6,045 to 7,285	Common walnut	2,830

(*h*) U. S. Tenth Census Report, small-size tests of T. P. Sharples. A very large number of American woods, 412 species, were tested in over 1,200 specimens. This series of tests is the most comprehensive, as regards the number of species, ever undertaken, but the results are more of comparative than practical value, as the number of specimens for each kind was very small and the specimens, as a rule, only 1 57-100 inches square in size. The pieces for tranverse tests were a little over three feet long, and those for compressive tests with the grain 12.6 inches long. Results for ultimate compression across grain were recorded for a pressure producing an indentation of 1-100 inch to 1-5 inch.

(*i*) U. S. Army tests by Captain Rodman (Ordnance Manual) were made over twenty-five years ago on small specimens, although

larger than other earlier experiments. The pieces for transverse tests were about three inches by six inches, and five feet span.

(*j*) Professor Thurston, for U. S. Geological Survey, 1880, forty small-size tests of Oregon pine and California spruce.

APPENDIX C.

U. S. FORESTRY DIVISION TESTS OF LONG-LEAF PINE.

The United States Agricultural Department, under the supervision of Dr. B. E. Fernow, Chief of Division of Forestry, has in progress the most thorough examination of timber physics on a large scale, based on truly scientific principles, ever undertaken in this country. The methods in use and the results were published in detail, during 1892 and 1893, in "Timber Physics," Parts I and II, Bulletins No. 6 and 8, Forestry Division, U. S. Department of Agriculture, since which time the work has been delayed owing to insufficient appropriations by Congress, although it is expected that Part III, giving the researches for the four important species of Yellow Pine, will be published the latter part of 1895.

The material examined up to 1893 was exclusively "Long-Leaf Pine" (*Pinus palustris*), cut from twenty-six specially selected trees from four different sites in Alabama. The range of the results of over two thousand mechanical tests, conducted by Prof. J. B. Johnson, at Washington university, St. Louis, Mo., on large and small specimens, is shown in the table herewith, the results having been reduced to the uniform basis of 15 per cent. moisture.

The following is offered in explanation of these tests:

Transverse Tests.—The full-size tests were made on a machine of 100,000 lbs. capacity, and the small-size tests on a machine capable of breaking a 4-inch square stick 6 feet long.

The ultimate extreme fiber stress is computed from the well known formula,—

$$f = \frac{3Wl}{2bh^2}$$

where f = stress on extreme fiber in lbs. per square inch.

W = load at centre of beam in lbs.

l = length of beam between supports in inches.

b = breadth of beam in inches.

h = height of beam in inches.

The results of each test were plotted as rectangular co-ordinates, using the loads as ordinates and the corresponding deflections as abscissas. The so-called elastic limit is determined from this curve by the arbitrary rule locating it at that point of the curve where the rate of deflection is 50 per cent. more than it is at first, it having been found that this rule usually places the elastic limit at the point where the deflection, after remaining almost proportional to the loads, suddenly begins to increase rapidly. The extreme fiber stress at the thus established elastic limit is calculated the same as the ultimate extreme fiber stress, using the load on the beam at the elastic limit in place of the ultimate breaking load.

CONDENSED TABLE OF RANGE OF MECHANICAL PROPERTIES OF "LONG-LEAF PINE."

Compiled from "Timber Physics," Part II, Bulletin No. 8, Forestry Division, U. S. Department of Agriculture.

[Ranges reduced to uniform basis of 15 per cent. moisture.]

		Butt Logs.		Middle Logs.		Top Logs.		Average of butt logs.	Grand average of all tests.
		Least.	Greatest	Least.	Greatest	Least.	Greatest		
Weight, in pounds, per cubic foot		28.00	64.79	35.85	58.56	30.18	56.56	47.83	46.27
Transverse strength.—	Modulus of rupture or ultimate breaking extreme fiber stress, in pounds, per square inch	4,762	16,200	7,640	17,128	4,268	15,554	12,614	12,250
	Extreme fiber stress at the elastic limit, in pounds, per square inch	4,930	13,110	5,540	11,790	2,553	11,950	9,460	9,430
	Modulus of elasticity, in pounds, per square inch	1,118,800	3,117,370	1,136,120	2,981,720	842,000	2,697,460	1,925,644	2,069,650
Crushing strength.—	Ultimate breaking compressive stress, with the grain, in pounds, per square inch	4,781	9,850	5,030	9,300	4,587	9,100	7,452	7,228
	Ultimate breaking compressive stress, across the grain, in pounds, per square inch	675	2,094	656	1,445	584	1,766	1,598	1,517
Tensile strength.—	Ultimate breaking tensile stress, in pounds, per square inch	8,600	31,890	6,330	29,500	4,170	23,280	17,359	*16,029
Shearing strength.—	Ultimate breaking shearing stress, with the grain, in pounds, per square inch	464	1,299	539	1,230	484	1,156	866	852

* Not reduced for moisture.

The modulus of elasticity for rectangular sections is computed from the well known formula,—

$$E = \frac{Wl^3}{4Dbh^3}$$

where E=modulus of elasticity.
D=deflection of beam in inches.
W, l, b and h same as above.

To find this modulus a tangent line is drawn to the strain diagram at its origin, and the co-ordinates of any point on this line used as the W and D from which to compute E. The modulus of elasticity is a true measure of the stiffness of the material, and is the most constant and reliable property of all kinds of engineering materials, and is a necessary means of computing all deflections or distortions under loads.

Crushing or Compression Tests.—The endwise compression tests were made, as a rule, on sticks 4 in. square and 8 in. long, although some tests were made on sticks 4 in. square and 40 in. long. The machine used was a Universal Testing machine.

The crushing or compression tests across grain were made on sticks 4 in. square and 6 in. long. The load is recorded when the limit of the distortion, *i. e.*, indentation, is 15 per cent. of the height, *i. e.*, thickness of timber compressed.

The department has a machine for testing full-size columns with a capacity of 1,000,000 lbs., capable of crushing a timber column 12 to 14 in. square, and up to a length of 36 ft. No tests had been made on this machine up to the spring of 1893, the date of the last published results.

Tensile Tests.—The tensile tests were made on a Universal Testing machine, the specimens being cut from the ends of previously broken beams, the section of specimens being 2½x⅜ in.

Dr. Fernow summarizes the more important deductions, that can be made on the basis of the tests of Long-Leaf Pine, published up to 1893, as follows:

"With the exception of tensile strength, a reduction of moisture is accompanied by an increase in strength, stiffness, and toughness.

"Variation in strength goes generally hand in hand with variation in specific gravity.

"The strongest timber is found in a region lying between the pith and the sap, at about one third of the radius from the pith in the butt log; in the top log the heart portion seems strongest. The difference in strength in the same log ranges, however, not over 12 per cent. of the average, except in crushing across the grain and shearing, where no relation according to radial situation is apparent.

"Regarding the variation of strength with the height in the tree, it was found that for the first 20 to 30 feet the values remain constant, then occurs a more or less gradual decrease of strength, which finally, at the height of 70 feet, amounts to 20 to 40 per cent. of that of the butt log for the various exhibitions of strength.

"In shearing and crushing across and parallel with the grain, practically no difference was found.

"Large beams appear 10 to 20 per cent. weaker than small pieces.

"Compression tests seem to furnish the best average statement of value of wood, and if one test only can be made this is the safest.

NAMES AND CHARACTERISTICS OF SOUTHERN LUMBER PINES.

From "Timber Physics," Part II, Bulletin No. 8, Forestry Division, U. S. Department of Agriculture.

NAMES.	BOTANICAL NAME.	*Pinus palustris* Miller. Syn. *P. australis* Michx.	*Pinus cubensis* Griesebach. Syn. *Pinus Tæda* var *heterophylla* Ell. *P. Elliottii* Engelm *P. cubensis* var. *terthrocarpa* Wright.	*Pinus echinata* Miller. Syn. *Pinus mitis* Michx. *Pinus virginiana* var. *echinata* Du Roi. *P. Tæda* var. *variabilis* Aiton. *P. variabilis* Lamb *P. rigida* Porcher.	*Pinus Tæda* Linn. Syn. *Pinus Tæda* var. *tenuifolia* Aiton.
	BEST COMMON NAME.	Long-Leaf Pine.	Cuban Pine.	Short-Leaf Pine.	Loblolly pine.
	Local, Market, and Lumbermen's Name.	Southern yellow pine. d w lantic). Long-leaved pitch-pine (Atlantic). Long-straw pine (Atlantic). North Carolina pitch-pine. Georgia yellow pine. Georgia pine. Georgia heart-pine. Georgia long-leaved pine. Georgia pitch-pine. Florida yellow pine. Florida pine. Florida long-leaved pine. Texas yellow pine. Texas long leav'd pine.	Slash-pine (Ga., Fla.).. and la.) E.	Yellow pine (N. C., Va.) Slash-pine (N. C., Va), in part. Old-field pine (Ala., Miss.). Bull-pine (?). Spruce-pine.	Slash-pine (Va. N. C.), in part. Loblolly-pine (Gulf Region). Old-field pine (Gulf Region). Rosemary-pine (N. C., Va.). Short-leaved pine (Va., N. C., S. C.). d).). n part. Bastard pine (Va., N.C.). Yellow pine (No. Ala., N. C.). Swamp pine (Va., N.C.). Long-straw pine (Va., N. C.), in part.

Botanical Diagnosis.	Leaves	3 in a bundle, 9 to 12 (exceptionally 14 to 15) inches long.	2 and 3 in a bundle; 7 to 12 (usually 9 to 10) inches long.	2 and 3 in a bundle; 1⅝ to 4 inches long; commonly 2½ to 4 inches.	3 in a bundle; 5 to 8 in's long.
	Cones (open)	6 to 9 inches long, 4½ to 5 inches in diameter.	4 to 6½ (usually 4 to 5) inches long; 3 to 4¾ inches in diameter.	1½ to 2 inches long; 1¼ to 1¾ inches in diameter.	2¼ to 4½ inches long; 1⅞ to 3 inches in diameter.
	Scales	¾ to 1 inch broad; tips much wrinkled, light chestnut brown, gray with age.	11-16 to ⅞ inch broad; tips, wrinkled; deep russet brown; shiny.	5-16 to ⅜ (exceptionally about ½) inch broad; tips light yellow-brown.	⅜ to ⅝ inch broad; tips smooth; dull yellow-brown.
	Prickles	Very short, delicate, incurved.	Very short; straight; declined.	Exceedingly short (1-10 inch), delicate straight, declined.	Short; stout at base.
	Buds	¾ inch long; ½ inch in diameter; silver white.	About ½ inch long; ¼ inch in diameter; brownish.	⅜ to ½ inch long; about ⅛ inch in diameter; brownish.	½ to ⅝ inch long; ¼ inch in diameter; brownish.
Diagnostic Features.	Specific gravity of kiln-dried wood. Possible range.	.58 to .90	.65 to .84 (Sarg.)	.39 to .76	.38 to .61
	Specific gravity of kiln-dried wood. Most frequent range.	.60 to .70	....	.50 to .60	.43 to .48
	W'ght, pou'd's pr. cubic foot, kiln-dried wood. Possible range.	44 to 52	38 to 50	36 to 44	31 to 36
	W'ght, pou'd's pr. cubic foot, kiln-dried wood. Average.	48	47	40	34
	Character of grain seen in cross section	Fine and even; annual rings uniformly narrow throughout; not less than 8 (mostly about 18-25) rings to the inch.	Variable and coarse; rings mostly wide; from 6 to 8 rings to the inch.	Very variable; medium, coarse; rings wide near heart; followed by zone of narrow rings; not less than 4 (mostly about 10) rings to the inch.	Less variable, mostly very coarse; 8 to 12 rings to the inch; generally wider than in short leaf.
	Color, general appearance	Even dark reddish-yellow to reddish-brown.	Dark straw color with tinge of flesh color.	Yellowish-red.	Whitish to brownish yellow; the dark bands of summer wood being proportionately narrow.
	Sapwood, proportion	Very little; rarely over 2 to 3 inches of radius.	Nearly one half of the radius.	Commonly over 4 inches of radius.	Very variable, ⅓ to ½ of the radius.
	Resin	Very abundant; tree turning into "light wood;" pitchy throughout.	Abundant, sometimes yielding more pitch than long-leaf; not turning into "light wood."	Moderately abundant, least pitchy; only near stumps, knots, and limbs.	Abundant; more than short-leaf, less than long-leaf and Cuban.

"The investigations into the effect of bleeding the trees for turpentine leave no doubt of the fact that bled timber is in no respect inferior to unbled timber."

The following additional extracts from Dr. Fernow's report, and the accompanying table herewith, copied from his report, will prove not only interesting and aid in defining the class of timber covered by these tests and called "Long-Leaf Pine," but will form a useful and valuable record, especially as the original publication (Bulletin No. 8) is out of print and difficult to obtain:

"There are in the Southern Atlantic and Gulf states ten species of pine which are or can be cut into lumber. Two of these—the white pine (*Pinus strobus* L.) and the pitch-pine, also called yellow or black pine (*Pinus rigida* Mill.)—occur only in small bodies on the Alleghany mountains, from Virginia down to northern Georgia, being rather Northern pines. Three—the Jersey or scrub-pine, occasionally also called short-leaf or spruce-pine (*Pinus virginiana* Mill.) along the coast to South Carolina; the sand, scrub, or spruce-pine [*Pinus clausa* (Engelm.) Sarg.], found in a few localities in Florida; and the pond, also called loblolly or Savannah pine (*Pinus serotina* Mx.) along the coast from North Carolina down to Florida—occur either so sparingly that they do not cut any figure on the lumber market, or do not often produce sizable trees for saw-logs.

"There remain, then, five distinctly Southern species which are actually cut for lumber; one of these, the spruce-pine, also called cedar pine or white pine (*Pinus glabra* Walt.) probably does not reach the market except by accident. But the other four may be found now in all the leading markets of the East.

"There exists considerable confusion among architects, builders, engineers, as well as dealers in lumber and lumbermen themselves, as to the identity of these species and their lumber. The confusion arises mainly from an indiscriminate use of local names, and from ignorance as to the differences in characteristics of their lumber as well as the difficulty in describing these.

"The table herewith, showing the names, which have been found applied to the four species furnishing Southern pine lumber, will most readily exhibit the difficulty arising from misapprehension of names. These names are used in the various markets and in various localities in the home of the trees. Where possible the locality in which the name is used has been placed in brackets by the side of the name."

Prof. J. B. Johnson makes the following statements regarding the extensive tests made under his charge as reported above:

"The long-leaf pine timber is specially fitted to be used as beams, joists, posts, stringers in wooden bridges, and as flooring when quarter-sawed. It is probably the strongest timber in large sizes to be had in the United States. In small selected specimens, other species, as oak and hickory, may exceed it in strength and toughness. Oak timber, when used in large sizes, is apt to be more or less cross-grained, knotty, and season-checked, so that large oak beams and posts will average much lower in strength than the long-leaf pine, which is usually free from these defects. The butt cuts are apt to be windshaken, however, which may weaken any large beams coming from the lower part of the tree. In this case the beam would fail by shearing or splitting along this fault with a much smaller load than it would carry without such defect. These wind shakes are readily seen by the inspector, and sticks containing them are easily excluded, if it is thought worth while to do so. For highway and railway wooden bridges and trestles, for the entire floor system of what is now

termed 'mill' or 'slow-burning' construction, for masts of vessels, for ordinary floors, joists, rafters, roof-trusses, mill-frames, derricks, and bearing piles; also for agricultural machinery, wagons, carriages, and especially for passenger and freight cars, in all their parts requiring strength and toughness, the long-leaf pine is peculiarly fitted. Its strength, as compared to that of short-leaf yellow pine and white pine, is probably very nearly in direct proportion to their relative weight, so that pound for pound all the pines are probably of about equal strength. The long-leaf pine is, however, so much heavier than these other varieties that its strength for given sizes is much greater.

"A great many tests have now been made on short-leaf and on loblolly pine, both of which may be classed with long-leaf as 'Southern yellow pine,' and from these tests it appears that both these species are inferior to the long-leaf in strength in about the ratio of their specific gravities. In other words, long-leaf pine (*Pinus palustris*) is about one third stronger and heavier than any other varieties of Southern yellow pine lumber found in the markets. It is altogether likely that a considerable proportion of the tests heretofore made on 'Southern yellow pine' have been made on one or both of these weaker varieties."

APPENDIX D.

PROFESSOR LANZA'S FULL-SIZE TRANSVERSE TESTS.

Professor Gaetano Lanza, of the Massachusetts Institute of Technology, author of "Applied Mechanics," and one of the best known writers and experimenters on the strength of timber in this country, obtained the following results from full-size transverse tests made in his Boston laboratory.

a. Transverse strength of spruce.

From sixty-eight full-size tests of spruce beams:—

Ultimate breaking extreme fibre stress in pounds per square inch, 2,828 to 8,748; average, 5,046.

Modulus of elasticity in pounds per square inch, 897,961 to 1,588,548; average, 1,332,500.

For the calculation of deflection of a spruce beam under a given load to be applied for a long time, the modulus of elasticity should be assumed as 666,300.

Professor Lanza states that, judging from results of spruce obtained from Boston, Mass., lumber yards, the ordinary run of spruce would not allow a higher ultimate breaking extreme fibre stress than 3,000 pounds, and even that might in some cases be too high; that the very best selected stock at any one lumber yard would not allow over 4,000 pounds to be used; and to allow 5,000 pounds per square inch to be used special sticks from different dealers would have to be collected, if a considerable amount of such lumber were desired.

b. Transverse strength of yellow pine.

From fifty-one full-size tests of yellow pine beams:—

Ultimate breaking extreme fibre stress in pounds per square inch, 3,963 to 11,360; average, 7,486.

Modulus of elasticity in pounds per square inch, 1,162,467 to 2,386,096; average, 1,757,900.

For the calculation of deflection of a yellow pine beam under a given

load to be applied for a long time, the modulus of elasticity should be assumed as 878,950.

Professor Lanza states that for yellow pine of fair quality it would not be correct to use for the ultimate breaking extreme fibre stress a number greater than 5,000 pounds per square inch, especially for large sizes, such as 9 x 14 inches, 12 x 16 inches, etc. Although the average result from the tests showed 7,486 pounds, nevertheless in the case of one particular beam it was 5,300, notwithstanding the fact that this beam was quite free from knots, cracks, crooked grain, and other defects, and had been selected as one of exceptionally good quality.

c. Transverse strength of white oak.

From thirty-six full-size tests of white oak cut in Pennsylvania and Ohio:—

Ultimate breaking extreme fibre stress in pounds per square inch, 3,535 to 7,834; average, 5,863.

Modulus of elasticity in pounds per square inch, 744,774 to 1,777,500; average, 1,131,100.

d. Transverse strength of white pine.

From thirty-seven full-size tests of white pine:—

Ultimate breaking extreme fibre stress in pounds per square inch, 2,456 to 7,251; average, 4,451.

Modulus of elasticity in pounds per square inch, 727,200 to 1,565,000; average, 1,122,000.

Eight full-size tests of kiln-dried western white pine showed an average ultimate breaking extreme fibre stress of 5,482, and an average modulus of elasticity of 1,183,037.

e. Transverse strength of hemlock.

From seventeen full-size tests of eastern and Vermont hemlock:—

Ultimate breaking extreme fibre stress in pounds per square inch, 2,059 to 6,535; average, 3,825.

Modulus of elasticity in pounds per square inch, 412,670 to 1,327,200: average, 922,250.

f. Time tests for deflection of timber beams under transverse strain.

From a large number of full-size time tests on spruce and yellow pine beams centrally loaded for different periods, some over half a year, Professor Lanza concludes that the deflection of a timber beam under a long-continued application of the load, may be two or more times that assumed when the load was first applied; and that, in order to compute it by means of the ordinary deflection formulae, the modulus of elasticity should be assumed at not more than one half the value obtained from quick tests.

APPENDIX E.

MISCELLANEOUS FULL-SIZE TESTS.

a. Some English full-size transverse tests of timber beams, made by Messrs. Edwin Clark, and C. Graham Smith, show the following average values for the ultimate breaking extreme fibre stress, and for the modulus of elasticity, both in pounds, per square inch:—

American red pine,	3 tests;	fibre stress,	4,842;	mod. elast.	1,204,943
Memel fir,	2 " ;	" "	5,274;	" "	1,855,900
European pitch pine,	4 " ;	" "	6,984;	" "	2,046,275
European red pine,	2 " ;	" "	4,572;	" "	1,247,000
Quebec yellow pine,	4 " ;	" "	4,491;	" "	1,309,833
Baltic fir,	2 " ;	" "	5,454;	" "	1,507,850

b. Messrs. David Kirkaldy & Son, London, England, made a series of full-size tests of American white oak in 1884, for the International Forestry Exhibition, Edinburg, 1884, with following results:—

All sticks, scant four and one-half inches by scant twelve inches; five tests for each average result.

Transverse tests, ultimate breaking extreme fibre stress in pounds per square inch:—five feet span, 6,890 pounds; eleven feet span, 8,550 pounds.

Compression tests, ultimate breaking stress in pounds per square inch:—twenty-five inches long, or about six diameters, 3,285 pounds; fifty inches long, or about eleven diameters, 3,418 pounds; 100 inches long, or about twenty-three diameters, 2,891 pounds.

APPENDIX F.

LONGITUDINAL SHEARING UNDER TRANSVERSE STRAIN.

Beams loaded transversely sometimes fail by shearing longitudinally along the neutral axis. The intensity i, of the longitudinal shearing stress in pounds per square inch in a rectangular beam, is expressed by the formula:—

$$i = \frac{3F}{2bh}$$

where F equals total vertical shear in pounds at the point of beam selected; and b and h respectively the breadth and height of beam in inches. For a centre load, W, this formula becomes:—

$$i = \frac{3W}{4bh}$$

a. Professor Lanza found the following average calculated values for the ultimate breaking longitudinal shearing stress in pounds per square inch for the different full-size beam tests conducted in his laboratory:—

For beams that failed by longitudinal shearing—

9 spruce beams,	average, . . .	198 lbs.
5 yellow pine beams,	average, . . .	222 "
2 white oak beams,	average, . . .	266 "
3 white pine beams,	average, . . .	151 "

For beams that failed by flexure, and not by longitudinal shearing—

58 spruce beams,	average, . . .	182 lbs.
45 yellow pine beams,	average, . . .	231 "
31 white oak beams,	average, . . .	176 "
33 white pine beams,	average, . . .	134 "
17 hemlock beams,	average, . . .	123 "

b. Professor Charles B. Wing, Leland Stanford University, California, published in *Engineering News*, March 14, 1895, an account of certain full-size tests of Douglas fir beams, two of which failed by longitudinal shearing under transverse loading, the value of the longitudinal shearing stress, calculated by the formula, having been respectively 185 and 143 pounds per square inch. The average calculated longitudinal shearing stress for nine of the full-size beams, that failed by flexure, was at the time of breaking 160 pounds per square inch, or probably very near the ultimate limit. Professor Wing concludes, from these results, that the danger of failure by longitudinal shearing should not be lost sight of in using large timber beams in flexure.

APPENDIX G.

PROFESSOR LANZA'S FULL-SIZE TESTS OF TIMBER COLUMNS.

a. An extensive series of full-size tests of wooden mill-columns were made in 1882 at the United States arsenal, Watertown, Mass., by Professor Lanza, for the Boston Manufacturers' Mutual Fire Insurance Company, the results having been published in a special pamphlet. The columns were generally round, and the ends as a rule flat. The least diameters varied from about 6 to 11 inches, the lengths from about 11 to 14 feet. A series of tests on blocks, 2 feet long, the same size as the columns, were also made, with the result that the ultimate crushing strength of the short blocks was very nearly practically the same as for the columns tested, for which the quotient of length divided by the least diameter varied from about 15 to about 25. In other words, colloquially speaking, the tests covered columns of about 15 to 25 diams.

The results show as follows:

Yellow pine posts and blocks, 18 tests: Ultimate breaking crushing strength in pounds per square inch, 3,604 to 5,452, average, 4,544; modulus of elasticity for crushing in pounds per square inch, 1,631,035 to 2,443,411, average, 1,996,351.

White oak posts and blocks, 10 tests: Ultimate breaking crushing strength in pounds per square inch, 3,132 to 4,450, average. 3,470; modulus of elasticity for crushing in pounds per square inch, 1,104,938 to 1,748,817.

Old and seasoned white oak posts (ten of which had been in use about 25 years), partly with uneven end bearings so as to represent actual conditions existing frequently in old structures, 18 tests: Ultimate breaking crushing strength in pounds per square inch, 2,943 to 6,147, average, 3,957 pounds; modulus of elasticity for crushing in pounds per square inch, 1,448,964 to 2,138,804.

Professor Lanza states, that in all these tests the columns gave way by direct crushing, and hence that the strength of columns of these ratios of length to diameter can properly be found by multiplying the crushing strength per square inch of the wood by the area of the section in square inches.

A set of tests was made of columns with eccentric loading, showing a great falling off of strength, due to the eccentricity of the load.

Professor Lanza offers among others the following conclusions, which are of interest for railroad work:

"The strength of a column of hard pine or oak, with flat ends, the load being uniformly distributed over the ends, and of the diamters tested, is practically independent of the length, for the ratios of length to diameter used in the tests, such columns giving way practi-

cally by direct crushing; the deflection, if any, being as a rule very small, and exerting no appreciable influence on the breaking strength.

"The crushing strength per square inch varies considerably in specimens of different degrees of seasoning, also in large and small specimens. The average crushing strength of such yellow pine posts as were tested, not thoroughly seasoned, and not very green, is about 4,400 pounds; whereas for such oak as was furnished me, which was green and knotty, but no more so than is usual for use in building, the average is about 3,200 pounds.

"I would recommend the use of iron caps and pintles, instead of wooden bolsters, as wood is very weak to resist crushing across the grain, and the wooden bolster will fail at a pressure far below that which the column is capable of resisting, and the unevenness of the pressure brought about by the bolster is so great as to sometimes crack the column at a pressure far below what it would otherwise sustain.

"Any cause which operates to distribute the pressure on the ends unevenly, or to force its resultant out of centre, is a source of weakness, and brings about a very considerable deflection, which exerts an important influence in reducing the breaking strength."

b. Several tests of some well-seasoned old spruce round struts, of excellent quality, with even flat end bearings, made at the Watertown arsenal for the Jackson Company, showed an average ultimate breaking crushing strength of 5,071 pounds per square inch, the diameter being slack 6 inches and the length full 10 feet, or, in other words, length of strut about 21 diams.

c. Professor Lanza presented at the December, 1894, meeting of the American Society of Mechanical Engineers the results of his latest tests of thirteen full-size fairly well-seasoned spruce columns of fair average quality obtained from Boston lumber yards. Rectangular specimens, about 8 to 10 inches wide, 8 to 12 inches high, and 6 to 18 feet spans. The ratios of length to least side varied from about 9 to 27. The specimens with the higher ratios broke by deflection, those with the lower ratios by crushing.

The results were as follows:

Ultimate breaking crushing stress in pounds per square inch, 1,969 for 15 diams. to 3,195 for 9 diams.; average 20 to 27 diams., 2,424; average 15 to 20 diams., 2,670; average 10 to 15 diams., 2,442; average 9 diams., 2,875; grand average, 2,540. Modulus of elasticity in pounds per square inch, 834,270 to 1,656,300; average, 1,280,260.

APPENDIX H.

U. S. GOVERNMENT FULL-SIZE TESTS OF TIMBER COLUMNS.

a. The most extensive and reliable set of tests of timber struts ever undertaken in this country were made by the United States government in 1880 to 1883, under the direction of Col. T. T. S. Laidley, U. S. A., at the United States arsenal, Watertown, Mass., recorded in Exec Doc. No. 12, 47th Congress, 1st session, and Exec. Doc. No. 1, 47th Congress, 2d session. The tests covered full-size white pine and yellow pine rectangular struts with flat end bearings. The areas of the sticks varied from 27 to 235 square inches, and the lengths from 4 to 28 feet. There were several hundred full-size sticks broken.

b. Prof. William H. Burr of Columbia college, New York city, analyzes these government tests of columns as follows:

Flat end yellow pine columns were observed to begin to fail with deflection at a length of about 22 diameters. The short yellow pine columns, of a less length than 22 diameters, gave an ultimate breaking compression stress in pounds per square inch of 3,430 to 5,677, averaging 4,442. The long yellow pine columns of a length from 22 to 62 diameters gave values respectively from about 3,500 pounds to 1,700 pounds.

Flat end white pine columns began to fail with deflection at a length of 32 diameters. Thirty short white pine columns of a less length than 32 diameters failed generally at knots by direct compression, and gave an ultimate breaking compression stress in pounds per square inch of 1,687 to 3,700, averaging 2,414. The long white pine columns of a length from 32 to 62 diameters gave values respectively from about 2,000 pounds to 1,000 pounds.

A large number of tests were made on compound columns formed of two or three sticks, separated by packing blocks and bolted together at the ends and at the centre. The tests showed that the compound columns possessed essentially the same ultimate resistance per square inch as each component stick considered as a column by itself.

c. Some additional full-size tests, made in 1881 for the United States government by Colonel Laidley at Watertown arsenal, on timber struts, showed as follows:

Very straight grained yellow pine, 20 years seasoning, 12 tests, ultimate breaking compressive stress in pounds per square inch, 5,593 to 8,644; average, 7,386.

Very slow growth yellow pine, 3 tests, ultimate breaking compressive stress in pounds per square inch, 7,820 to 10,250; average, 9,339.

Very green and wet yellow pine, 3 tests, ultimate breaking compressive stress in pounds per square inch, 2,795 to 3,180; average, 3,015.

Spruce, thoroughly seasoned, full-size struts, 12 tests, ultimate breaking compressive stress in pounds per square inch, 3,967 to 5,754; average, 4,873.

APPENDIX I.

PROFESSOR BURR'S FORMULÆ FOR TIMBER COLUMNS.

Professor William H. Burr, of Columbia college, New York, author of "Elasticity and Resistance of the Materials of Engineering," offers the following formulæ for timber struts based upon the above government tests, in which formulæ

p = ultimate breaking compression stress in pounds per square inch;
l = length of strut in inches;
d = least side or diameter of strut in inches;
s = safe working compression stress in pounds per square inch.

For yellow pine $$p = 5{,}800 - 70\frac{l}{d}$$

For white pine $$p = 3{,}800 - 47\frac{l}{d}$$

For wooden railway structures, with a factor of safety of about 8, these formulæ will read for the safe working stress:

For yellow pine $$s = 750 - 9\frac{l}{d}$$

For white pine $$s = 500 - 6\frac{l}{d}$$

For temporary structures, such as bridge falseworks carrying no traffic, with a factor of safety of about 4, these formulæ will read for the safe working stress:

For yellow pine $$s = 1{,}500 - 18\frac{l}{d}$$

For white pine $$s = 1{,}000 - 12\frac{l}{d}$$

The preceding formulæ are to be used only between the limits of $20\frac{l}{d}$ and $60\frac{l}{d}$ for yellow pine, and between $30\frac{l}{d}$ and $60\frac{l}{d}$ for white pine.

For short columns below $20\frac{l}{d}$ and $30\frac{l}{d}$, respectively for yellow and white pine, use the following unit stresses in pounds per square inch.

	Ultimate.	Safe for railway bridges.	Safe for temporary structures.
Yellow pine	p = 4400	s = 550	s = 1100
White pine	p = 2400	s = 300	s = 600

All these values are applicable to good average lumber for the practical purposes indicated.

APPENDIX J.

PROFESSOR ELY'S FORMULÆ FOR TIMBER COLUMNS.

Mr. Edward F. Ely, instructor Massachusetts Institute of Technology, Boston, gives the following rule and unit co-efficients for timber columns based upon the above mentioned government tests. The average and the lowest results of these tests were plotted and the following rule established from the diagrams:

Total breaking strength of column in pounds equals area of section in square inches multiplied by the ultimate breaking crushing strength in pounds per square inch.

The ultimate breaking crushing strength in pounds per square inch for each particular case is obtained from the following table, it being dependent on the ratio of the length to the least side of the rectangular strut.

Kind of Timber.	Length in inches divided by least side of strut in inches.	Ultimate crushing strength in lbs. per square inch.
White Pine............	0 to 10	2,500
	10 to 35	2,000
	35 to 45	1,500
	45 to 60	1,000
Yellow Pine...........	0 to 15	4,000
	15 to 30	3,500
	30 to 40	3,000
	40 to 45	2,500
	45 to 50	2,000
	50 to 60	1,500

APPENDIX K.

PROFESSOR STANWOOD'S FORMULÆ FOR TIMBER COLUMNS.

Mr. James H. Stanwood, instructor Massachusetts Institute of Technology, published in *The American Architect and Building News* of April 9, 1892, and of March 10, 1894, the following formulæ for timber struts based upon the full-size U. S. government tests made at the Watertown Arsenal, and also on full-size tests of Professor Lanza. The experimental data for full-size white and yellow pine struts, on which the formulæ are based, are quite extensive and reliable, while there is not so much information at hand covering full-size tests of oak and of spruce columns.

The formulæ for the ultimate breaking crushing strength per square inch of columns with square ends are as follows:

For yellow pine $$s = 4{,}250 - 43\tfrac{1}{3}\frac{l}{d}$$

For white pine $$s = 3{,}150 - 40\frac{l}{d}$$

Where s = ultimate breaking crushing stress in pounds per square inch;
l = length of column in inches;
d = least diameter in inches.

The following safe working formulæ are recommended:

For yellow pine or white oak (using a factor-of-safety of about 4¼)

$$s = 1{,}000 - 10\frac{l}{d}$$

For white pine or spruce (using a factor-of-safety of 4)

$$s = 800 - 10\frac{l}{d}$$

Where s = allowable safe working crushing stress in pounds per square inch, and l and d, same as above.

APPENDIX L.

C. SHALER SMITH'S FORMULÆ FOR TIMBER COLUMNS.

Professor Burr, in his book "Elasticity and Resistance of the Materials of Engineering," gives certain data relative to C. Shaler Smith's formula for timber columns that will prove very interesting owing to the extensive use that has been made of this formula.

Mr. C. Shaler Smith conducted, during the winter of 1861–'62, a series of over 1,200 tests of full-size yellow pine spuare and rectangular columns for the ordnance department of the Confederate government, from which his well-known formula for timber struts was developed.

The tests were grouped as follows:

1. Green, half-seasoned sticks answering to the specification "good merchantable lumber."
2. Selected sticks reasonably straight, and air-seasoned under cover for two years and over.
3. Average sticks cut from lumber which had been in open air service for four years and over.

The formulæ for these three groups were,—

For No. 1: $$p = \frac{5{,}400}{1 + \frac{1}{250}\frac{l^2}{d^2}}$$

For No. 2: $$p = \frac{8{,}200}{1 + \frac{1}{300}\frac{l^2}{d^2}}$$

For No. 3: $$p = \frac{5{,}000}{1 + \frac{1}{250}\frac{l^2}{d^2}}$$

Where l = length of column in inches;
d = least side or diameter of column in inches;
p = ultimate breaking compressive stress in pounds per square inch.

In order to provide against ordinary deterioration, and also reck-

less building, bad workmanship, etc., Mr. Smith recommended the formula for group No. 3 as the best for general application.

He also recommended that the factor-of-safety shall be the square root of the quotient of the length divided by the least diameter until twenty-five diameters are reached, and five thence forward up to sixty diameters, which last limit is the extreme for good practice.

Mr. Smith's formula formed the basis of the principal timber column tables in "Trautwine's Pocket Book," but comparison with more recent results of full-size tests will show that it is very safe, unless very bad workmanship or an unusual set of conditions prevails.

Mr. Smith recommended for white pine columns the use of formula No. 3 with 3,000 substituted for the constant 5,000.

APPENDIX M.

PROFESSOR BOVEY'S FULL-SIZE TESTS OF CANADIAN DOUGLAS FIR, RED PINE, WHITE PINE, AND SPRUCE.

Professor Henry T. Bovey, of McGill University, Montreal, Can., presented a most valuable and voluminous paper on "The Strength of Canadian Douglas Fir, Red Pine, White Pine, and Spruce," to the Canadian Society of Civil Engineers, Transactions, Vol. IX, January 25, 1895, based upon the experiments conducted for a period of more than two years in the testing laboratories of McGill University. The paper covers 110 pages of the printed transactions and gives minute information as to the manner of conducting the tests, the origin, quality, and condition of the timber tested, as also full and detail results of the tests. A synopsis of this valuable paper is all that can be attempted here. Parties directly interested should obtain the full report by addressing Professor Bovey or the Canadian Society of Civil Engineers at Montreal.

Professor Bovey makes the following general remark:—"The tables showing the deflection of beams under transverse loading, and also the tables showing the extension of specimens under direct tension, tend to prove conclusively the statement made by the author many years ago, *i. e.*, that timber, unlike iron and steel, may be strained to a point near the breaking point without being seriously injured. It will be observed that in almost all cases the increments of deflection and extension, almost up to the point of fracture, are very nearly proportional to the increments of load, and it seems impossible to define a limit of elasticity for timber. This probably accounts for the continued existence of many timber structures in which the timbers have been and are still continually subjected to excessive stresses, the factor of safety being often less than 1½. Whether it is advisable so to strain timber is another question, and experiments are still required to show how timber is affected by frequently repeated strains."

The Douglas fir used in these tests came from British Columbia. The red pine was cut in 1893 in the neighborhood of the Bonnechere river, Nipissing District, County Renfrew, Ontario (west of the city of Ottawa). The white pine came from the valleys of tributaries of the Ottawa river, northerly and westerly from the city of Ottawa. The new spruce was cut near the Skeena river, British Columbia, on the Pacific coast, about 600 miles north of Victoria. The old spruce was from the Province of Quebec, west of Maine.

I. TRANSVERSE STRENGTH.

In the transverse tests the results given are the calculated "Maximum Skin Stress" (ultimate breaking extreme fibre stress) in pounds per square inch, and the "Co-efficient of Elasticity" (modulus of elasticity) in pounds, corresponding to the actual breaking load applied at the center of the span.

All the tests were made on large size sticks with spans varying from 5½ feet to 24 feet.

The weight of timber is given in pounds per cubic foot at date of test.

a. Transverse strength of Canadian Douglas fir.

Large size sticks, spans 5½ to 17 feet, breaking load applied centrally.

	Maximum skin stress lbs. per square inch.	Co-efficient of elasticity. pounds.	Weight in lbs. per cu. foot.
New timber, Specially Selected, Four tests. minimum	8,020	1,934,500	38.92
maximum	10,441	2,178,100	41.22
average	9,054	2,036,529	40.02
New timber, First quality, Fifteen tests. minimum	4,027	926,500	28.27
maximum	8,382	1,770,563	37.80
average	6,081	1,431,209	33.80
Old trestle timber:			
6½ years in use	6,135	1,201,620	32.80
8 " "	7,339	1,878,950	38.59
9 " "	7,086	1,665,560	33.75
11 " "	4,613	949,720	33.11

Professor Bovey recommends the following data for adoption in practice:

"In the case of specially selected timber, free from knots, with sound, clear, and straight grain, and cut out of the log at a distance from the heart,—

Average weight in lbs. per cubic foot = 40.
Average coefficient of elasticity in lbs. per square inch = 2,000,000.
Average maximum skin stress in lbs. per square inch = 9,000.
Safe working skin stress in lbs. per square inch = 3,000.

"In the case of first quality timber, such as is ordinarily found in the market,—

Average weight in lbs. per cubic foot = 34.
Average coefficient of elasticity in lbs. per square inch = 1,430,000.
Average maximum skin stress in lbs. per square inch = 6,000.
Safe working skin stress in lbs. per square inch = 2,000.

"In specifying these data it will be observed that 3 is adopted as the factor of safety. Upon this hypothesis the factor of safety for the

stick giving the minimum skin stress is more than 2, and this, in the opinion of the author, is an ample factor for a material which experience and all experiments show, may be strained without danger very nearly up to the point of fracture.

"Further, the results obtained in the experiments with the old stringers show that the strength of the timber had been retained to a very large extent, and that the rotting had not extended to such a depth below the skin as to sensibly affect the efficiency of the sticks, which still possessed ample strength for the work they were designed to do.

"If 2 is adopted as the factor of safety, and, in the opinion of the author, 2 is an ample factor for the great majority of cases, the rotting [in these old stringers] might extend without danger to a depth of 3.4 inches.

"Again, it will be observed that the skin stress and the elasticity are subject to a wide variation. This variation is due to many causes, of which the most important are the presence of knots, obliquity of grain, and, more than all, the locality in which the timber was grown, the original position of the stick in the log from which it was cut, and the proportion of hard to soft fibre, or of the summer to the spring growth. The tensile, shearing, and compressive experiments upon specimens cut out of different parts of the same log all show that the timber near the heart possesses much less strength and stiffness than the timber at a distance from the heart.

"A careful study of the results obtained up to date would seem to indicate that the best classification defining the strength of the timber would be found by dividing the section of a log into three parts by means of two circles, with the heart as the centre, and by designating the central portion as third quality, the portion between the two circles as second quality, and the outermost portion as first quality."

A most interesting paper on the structural characteristics of Douglas fir from a botanical standpoint was read by Professor Penhallow, F. R. S. C., at the meeting of the Royal Society of Canada, in Ottawa, in 1894, in connection with a paper by Professor Bovey on the strength of the timber (Transactions Royal Society of Canada, Section III, 1894, Papers Nos. II and III).

b. Transverse strength of Canadian red pine.

Large size sticks; spans, 13 to 17½ feet; breaking load applied centrally.

		Maximum Skin Stress. lbs. per sq. inch.	Co-efficient of elasticity. lbs.	Weight in lbs. per cubic foot.
New Timber, 6x7 in. to 6x13 in., 6 tests.	Minimum......	3,937	1,198,550	30.96
	Maximum.....	6,752	1,802,633	37.55
	Average.......	5,137	1,434,747	34.78
New Timber, 3x8 in. to 3x11 in., 4 tests.	Minimum......	4,339	1,575,200	31.56
	Maximum.....	6,928	1,784,800	37.69
	Average.......	5,725	1,648,519	34.43

Professor Bovey recommends the following data for adoption in practice:

Average weight in lbs. per cubic foot = 34.6.
Average coefficient of elasticity in lbs. per square inch = 1,430,000.
Average maximum skin stress in lbs. per square inch = 5,100.
Average safe working skin stress in lbs. per square inch (3 being the factor of safety) = 1,700.

"In the accounts of the several beams it will be observed that the failures are almost invariably due to the crippling of the material on the side in compression, indicating that the tensile strength of the timber exceeds its compressive strength, and this was subsequently verified by the direct tension and compression experiments."

c. *Transverse strength of Canadian white pine.*

Sizes 9 in. x 15 in. and 9 in. x 18 in.; spans, 8 1-2 to 24 feet; breaking load applied centrally.

		Maximum Skin Stress. lbs. per sq. inch.	Co-efficient of Elasticity. lbs.	Weight in lbs. per cubic foot.
New Timber, 15 tests.	Minimum......	2,500	433,250	33.64
	Maximum.....	4.936	1,184,240	41.49
	Average.......	3,388	754,265	37.88
Old Stringers, in use 8 years, 3 tests.	Minimum.....	2,495	650,930	26.08
	Maximum	3,589	982,480	28.30
	Average	3,099	854,333	27.54

Professor Bovey recommends the following data for adoption in practice:

Average weight in lbs. per cubic foot = 37.8
Average coefficient of elasticity in lbs. per square inch = 754,000.
Average maximum skin stress in lbs. per square inch = 3,300.
Average safe working skin stress in lbs. per square inch (3 being the factor of safety) = 1,100.

"Further experiments will probably show that these data require some modification. The actual skin stress and coefficients of elasticity are certainly greater than those given above."

d. *Transverse strength of Canadian spruce.*

Large size sticks; spans 10 to 24 feet; breaking load applied centrally.

		Maximum Skin Stress. lbs. per sq. inch.	Co-efficient of Elasticity. lbs.	Weight in lbs. per cubic foot.
New Timber, 3 tests, all from same log.	Minimum....	4,614	1,011,450	26.61
	Maximum....	5,908	1,528,499	26.61
	Average	5,120	1,203,633	26.61
Old Bridge and Culvert Stringers, 3 to 8 years in use, 5 tests.	Minimum	2,934	905,601	26.47
	Maximum	5,709	1,352,250	33.09
	Average..	3,875	1,189,800	29.15

II.—COMPRESSIVE STRENGTH.

The tests for compressive strength were made on sticks with from 5 to 40 square inches of cross-section, and in lengths from a few inches up to 6 1-2 feet. The result given in each case is the ultimate breaking load in lbs. per square inch of cross-section of stick.

The experiments were made chiefly with columns cut out of the sticks already tested transversely. These columns were carefully examined to see that the previous test of stick had caused no injury.

Professor Bovey states that the following inferences from the compressive tests may be drawn:

"The compressive strength of Douglas fir and of other soft timbers is much less near the heart than at a distance from the heart. The compressive strength of the timber increases with the density of the annular rings.

"When knots are present in a timber column, the column will almost invariably fail at a knot, or in consequence of the proximity of a knot.

"Any imperfection, as, for example, a small hole made by an ordinary cant hook, tends to introduce incipient bending or crippling.

"When the failures of average specimens commence by an initial bending, the compressive strengths of columns of about 10 to 25 diameters in length agree very well with the results obtained by Gordon's formula, the coefficients of direct compressive strength per square inch being 6,000 lbs. for Douglas fir, and 5,000 lbs. for white pine.

"Gordon's formula, however, is not at all applicable in the case of specially good or bad specimens. It is often found that a very clear, sound specimen, of even more than 20 diameters in length, will show no signs of bending, but will suddenly fail by crippling under a load as great as that sufficient to crush a shorter specimen.

"The greatest care should be observed in avoiding obliqueness of grain in columns, as the *effective* bearing area, and therefore also the strength, are considerably diminished.

"If the end bearings are not perfectly flat and parallel, the columns will in all probability fail by bending concave to the longest side.

"The *average* strength per square inch, independent of the ratio of length to diameter, is,—

New Douglas fir................5,974 lbs., average of 122 tests.
Old Douglas fir................6,265 " " 54 "

New red pine....................	4,067 lbs.,	average of	35	tests.
New white pine..................	3,843 "	"	68	"
Old white pine...................	2,772 "	"	56	"
New spruce (British Columbia).	3,617 "	"	69	"
Old spruce......................	5,136 "	"	20	"

"It should be pointed out that none of the old Douglas fir columns exceeded 4.4 diameters in length, while the great majority of the new Douglas fir columns were from 4 to 25 diameters in length. This explains the reason of the greater average compressive strength of the old Douglas fir. A similar remark applies to the new and old spruce."

III. TENSILE STRENGTH.

The tests for tensile strength were made on uninjured pieces of the beams previously broken by transverse strain. The specimens were less than one square inch in cross-section. Particular attention was paid to the effect of repeated loadings, also to a comparison of strength and stiffness in different portions of the same log. The recorded results are too voluminous to be given here in detail.

Professor Bovey states that the results of the tensile tests will show:—

"That the increments of extension, up to the point of fracture, are almost directly proportional to the increments of load.

"That the presence of knots is most detrimental both to the strength and to the stiffness, inasmuch as they practically diminish the effective sectional area, and also produce a curvature in the grain.

"That wood near the heart possesses much less strength, and much less stiffness than that more distant from the heart.

"That the strength and stiffness are also dependent upon the proportion of summer to spring growth.

"That irregularities of readings, both with the extensometer and with the rule, are chiefly due to the presence of a knot, or to curly or oblique grain caused by a knot."

a. Tensile strength of Canadian Douglas fir.

Owing to the small size of the specimens, the variations in the quality of the material, especially the presence of a knot or curly or oblique grain, cause a most marked difference in the recorded tensile breaking weight in pounds per square inch of cross-section.

The results of seventy-one tests of new Douglas fir vary from 2,485 to 18,856 pounds; averaging 11.612 pounds.

If the thirteen results less than 8,000 pounds be excluded, as being clearly caused by imperfections in the material, the average of the remaining fifty-eight tests will be 12,955.

To show that the recorded maximum of 18,856 pounds is not a phenomenon or an error, it would be well to mention that there are fifteen results from 15,000 to 18,856 pounds; namely, nine above 15,000, two above 16,000, two above 17,000, and two above 18,000.

Four tests of old Douglas fir showed a minimum tensile strength of 11,414 pounds per square inch, a maximum of 13,954 pounds, and an average of 12,663 pounds.

b. Tensile strength of Canadian red pine.

Nine tests of red pine showed a minimum tensile strength of 6,274 pounds per square inch, a maximum of 14,372 pounds, and an average of 10,644 pounds.

c. Tensile strength of Canadian white pine.

Ten tests of white pine showed a minimum tensile strength of 8,503 pounds per square inch, a maximum of 14,273 pounds, and an average of 11,396 pounds.

d. Tensile strength of old Canadian spruce.

Fifteen tests of old Canadian spruce showed a minimum tensile strength of 7,662 pounds per square inch, a maximum of 12,792 pounds, and an average of 9,793 pounds.

IV. SHEARING STRENGTH.

Great difficulty is encountered in tests for shearing strength to get absolutely reliable results.

The shearing strengths, which are of importance, are the resistances along planes tangential and radial to the annular rings. The compound shearing strength can be considered as the resultant of the tangential and radial shears.

Professor Bovey states that the following inferences may be drawn from the results of the shearing experiments:—

"The shearing strength of the timbers is much less near the heart than at a distance from the heart.

"Generally speaking, the shearing strength increases with the weight per cubic foot.

"The shearing strength increases with the density of the annular rings, or rather with the proportion of hard to soft fibre.

"A failure sometimes occurs, for which it is difficult to find a complete explanation.

"As a result of the experiments, the average [breaking] shearing strength of Douglas fir in pounds per square inch is 411, 377, or 403, according as the plane of shear is tangential, at right angles, or oblique to the annular rings.

"In practice, therefore, it will be safe to adopt as the average [breaking] co-efficients of shearing strength for Douglas fir, 400 pounds per square inch for shears tangential and oblique to the annular rings, and 375 pounds per square inch for shears at right angles to the annular rings."

Average Breaking Shearing Strength in pounds, per square inch.

Kind of Timber.	Tangential Shear.	Radial Shear.	Oblique Shear.
New Douglas fir	411	377	403
Old Douglas fir	302	310	371
Canadian red pine	392	....	333
Canadian white pine	382	273	363
Old Canadian spruce	332	389	382

The number of tests on which above table is based is not very large, which fact, combined with the acknowledged difficulty of obtaining accurate shearing tests, should cause the data presented to be considered as approximate only.

APPENDIX N.

REPORT OF WASHINGTON STATE CHAPTER, AMERICAN INSTITUTE OF ARCHITECTS, ON STRENGTH OF STATE OF WASHINGTON TIMBERS.

In the *California Architect and Building News*, of March, 1895, there is published a report of a special committee of the Washington State Chapter of the American Institute of Architects on "Authenticated Tests of Building Materials of the State of Washington," which gives valuable information from actual breaking tests of the transverse strength of Washington timbers, the figures given below indicating the calculated ultimate breaking stress in extreme fibre in pounds per square inch, based upon the actual breaking load applied at the centre of the span.

a. Transverse tests by C. B. Talbot, Civil Engineer, Northern Pacific Railroad.

Size, 2x4 inches; span, 4 feet. Ultimate extreme fibre stress in pounds per square inch.

Washington yellow fir, age, 1 1-2 months to 6 years; minimum, 6,890 lbs.; maximum, 9,720 lbs.; average of 5 tests, 7,847 lbs.

b. Transverse tests by A. J. Hart, M. C., Chicago, Milwaukee, and St. Paul Railway.

Sizes, 6x14 inches, 8x16 inches, and 9x16 inches; span, 16 to 20 feet. Ultimate extreme fibre stress in pounds per square inch.

Washington yellow fir, age, 1 day cut; minimum, 6,143 lbs.; maximum, 7,982 lbs.; average of 4 tests, 7,323 lbs.

Ditto, age, 6 years; minimum, 5,953 lbs.; maximum, 6,088 lbs.; average of 2 tests, 6,020 lbs.

Ditto, used 6 years in a bridge; minimum, 4,138 lbs.; maximum, 5,817 lbs.; average of 2 tests, 4,978 lbs.

c. Transverse tests at mills of St. Paul and Tacoma Lumber Company, Tacoma, Washington, March, 1890, by A. J. Hart and C. B. Talbot.

Sizes, 6x14 inches, 8x16 inches, and 9x16 inches; spans, 11 to 17 feet. Ultimate extreme fibre stress in pounds per square inch.

Washington (Douglas) fir, minimum, 5,263 lbs.; maximum, 7,561 lbs.; average of 9 tests, 6,273 lbs.

Ditto, age, 3 years; 1 test, 5,591 lbs.

Ditto, age, 6 years; 1 test, 3,725 lbs.

Ditto, culled stick; 1 test, 3,544 lbs.

d. Transverse tests by S. Kedzie Smith, City Engineer, Ballard, Washington.

Sizes, 3x8 inches, 3x12 inches, and 4x12 inches; spans, 8 to 14 feet. Ultimate extreme fibre stress in pounds per square inch. Quality of lumber a little above the grade of good merchantable lumber, air seasoned for forty days.

Washington red fir, medium fine grained; 1 test, 6,138 lbs.

Ditto, coarse grained; minimum, 4,605 lbs.; maximum, 5,700 lbs.; average of 6 tests, 5,182 lbs.

Ditto, very coarse grained; 1 test, 4,255 lbs.

Ditto, grand average of above 8 tests, 5,186 lbs.

Washington yellow fir, close grained; minimum, 7,500 lbs.; maximum, 8,160 lbs.; average of 2 tests, 7,830 lbs.

e. Comparative transverse tests by C. B. Talbot, Civil Engineer, Northern Pacific Railroad.

Size, 2x4 inches; length, 4 feet; clear span, 3 feet 9 inches; breaking load applied at centre of span. Ultimate extreme fibre stress in pounds per square inch.

Washington fir, age, 3 months; hard, fine grained; actual breaking load, 4,320 lbs.; extreme fibre strain, 9,720 lbs.

Cœur d' Alene (Washington) pine, age, 1 1-2 months; fine grained; actual breaking load, 2,274 lbs.; extreme fibre strain, 5,116 lbs.

Eastern oak, age, 1 year; dry; actual breaking load, 2,428 lbs.; extreme fibre strain, 5,463 lbs.

Eastern white pine, age, 1 year; dry; actual breaking load, 1,610 lbs.; extreme fibre strain, 3,622 lbs.

In other words, the transverse strength of Eastern white pine, Eastern oak, Washington pine, and Washington fir, is relatively proportional to 1,610, 2,428, 5,116, and 9,720, or approximately as 1 to 1 1-2, to 3 1-5 to 6.

f. The following are the averages of all tests for transverse strength, (excepting culls, and old bridge timbers) mentioned in the above committee report, giving the ultimate breaking extreme fibre stress per square inch:—

Washington yellow fir, 13 tests, 7,402 lbs.

Douglas fir, 11 tests, 5,979 lbs.

Washington red fir, 8 tests, 5,186 lbs.

Grand average of all kinds of Washington or Douglas fir, 32 tests, 6,359 lbs.

APPENDIX O.

MISCELLANEOUS TESTS OF THE NORTHWEST AND PACIFIC COAST TIMBERS.

a. In addition to 10 full-size tests of Washington fir, mentioned above (Appendix "N, d"), Mr. S. Kedzie Smith, city engineer, Ballard, Wash., made 9 similar tests reported in *The Puget Sound Lumberman*, August, 1894, and February, 1895. The results from these 19 full-size tests are,—

Ultimate extreme fibre stress in pounds per square inch, 3,530 to 8,160, average 5,420.

b. Mr. Arthur Brown, superintendent bridges and buildings, Southern Pacific Railroad, established following average ultimate breaking stresses as results of tests of Pacific Northwest fir (*The Puget Sound Lumberman*, February, 1894):

Tensile,	15,900	lbs.	per square	inch.
Crushing,	6,000	"	"	"
Shearing with the grain,	600	"	"	"
Modulus of elasticity,	1,272,000	"	"	"
Transverse (extreme fibre stress)	13,630	"	"	"

c. The results of about 40 transverse tests of California Spruce and Oregon Pine, made by Professor Thurston at the Stevens Institute of

Technology for the United States Geological Survey in 1880, were as follows:

Average Ultimate Breaking Extreme fibre stress in pounds per square inch, for California Spruce, 12,228 and for Oregon pine, 11,071.

Average Ultimate Breaking Compressive stress for short pieces in pounds per square inch, for California spruce, 9,200 pounds to 12,800, and for Oregon pine, 9,200 to 11,500.

d. In *Engineering News* of April 20, 1893, Mr. W. B. Wright, formerly division engineer, M., St. P. & S. Ste. M. Railway, gives information relative to some tests of Oregon pine or Douglas fir from the state of Washington made by Mr. Geo. S. Morrison at the Pittsburgh Testing Laboratory, in 1886. There is a distinction made between red and yellow fir. The average co-efficients of ultimate breaking strength in pounds per square inch were as follows:

Compression, Red Fir, 2 tests, 6,099 lbs.
Yellow Fir, 2 tests, 6,132 lbs.
Tension, Red Fir, 4 tests, 10,872 lbs.
Yellow Fir, 5 tests, 11,550 lbs.
Transverse Strength, Red Fir, 11 tests, 15,894 lbs.
Yellow Fir, 9 tests, 15,030 lbs.

e. A few small-size tests of Douglas fir and Oregon Sugar pine were made at the machine shops of the Oregon & California Railroad with results given below. Specimens for crushing test were 1 inch square and 24 inches long; for transverse test, 1 inch square and 12 inches span; for tensile test, 1-10 inch by 1 inch.

Ultimate Breaking Strength in Pounds per Square Inch.

	Douglas Fir.	Oregon Sugar Pine.
Crushing strength (24 diams.)......	3,085	3,391
Transverse strength, extreme fibre stress..........	8,658	8,370
Tensile strength..........	16,600	11,000
Sidewise crushing at 1000 lbs. pressure per square inch..........	2-100 in. indent.	4-100 in. indent.
Shearing strength, 13 tests		
Least..........	515	
Greatest..........	833	
Average..........	689	

APPENDIX P.

PROFESSOR SOULE'S TESTS OF CALIFORNIA REDWOOD.

Special Bulletin No. 2, June 1, 1895, University of California, Department of Civil Engineering, gives the data from tests thus far conducted on California Redwood in the University laboratory by Mr. Frank Soulé, professor of civil engineering, as follows:

Clear, straight-grained, well air-seasoned and dry Humboldt Redwood (*Sequoia Sempervirens*).

Average specific gravity of 126 pieces, .48.

Average weight per cubic foot, 29.91 pounds.

Percentage of moisture, average, 15 per cent.

Ultimate Strength,	Tension, 27 specimens,	6,521	lbs.	per square	inch.
"	Compression, longitudinal, 31 specimens,	4,385	"	"	"
"	Compression across the fibre, reduction in height of piece of 3 per cent., 30 specimens,	966	"	"	"
"	Compression across the fibre, reduction in height of 15 per cent., 30 specimens,	1,197	"	"	"
"	Longitudinal shear (pieces clamped to prevent splitting) 8 specimens,	548	"	"	"
"	Modulus of rupture, 9 specimens,	4,955	"		
"	Coefficient (modulus) of elasticity, 8 specimens,	797,467	"		

APPENDIX Q.

UNITED STATES GOVERNMENT WATERTOWN ARSENAL TESTS OF THE SHEARING STRENGTH OF TIMBER WITH THE GRAIN RESISTING THE PULLING OUT OF PINS OR KEYS.

Col. T. T. S. Laidley, United States army, made some tests for the United States government in 1881, at the Watertown arsenal on the resistance offered by timber to the shearing out of round bolts or square keys, the force being exerted with the grain of the timber. The bolts and square keys were of wrought iron, the bolts 1 inch in diameter, and the keys 1 inch and 1 1-8 inch. The timber specimens were 2 inches thick and thoroughly seasoned. The surface resisting shearing was therefore twice the distance of the center of the hole from the end of the stick multiplied by the thickness of the stick, which in this case was two inches.

Ultimate Breaking Shearing Stress with the grain in pounds per square inch resisting the tearing out of bolts and keys.

Timber.	Centre of Hole from End of Specimen.					Average.
	2 in.	4 in.	6 in.	7 in.	8 in.	
Spruce:						
Round bolt..	399	359	275	....	202	309
Square key..	410	329	242	279	....	315
White pine:						
Round bolt..	457	611	450	....	327	461
Square key..	550	412	332	236	....	382
Yellow pine:						
Round bolt..	607	720	456	....	337	530
Square key..	599	369	572	438	....	494

APPENDIX R.

TRANSVERSE TESTS OF FULL-SIZE OLD AND NEW BRIDGE STRINGERS MADE FOR THE CHICAGO, MILWAUKEE, AND ST. PAUL RAILWAY, UNDER THE DIRECTION OF MR. ONWARD BATES.

Mr. Onward Bates, engineer and superintendent of bridges and buildings, Chicago, Milwaukee & St. Paul Railway, presented a paper on "Pine Stringers and Floor Beams for Bridges," to the American Society of Civil Engineers (Transactions, November, 1890), in which the detail results are given of 67 full-size tests of new and old bridge stringers of white pine, Norway pine, and Douglas fir, made under Mr. Bates's direction.

Mr. Bates states that the tests lead to the following conclusions:

"Green timber is not as strong as after it has seasoned."

"Age and use do not weaken the timber. It preserves its strength until weakened by decay."

"Knots do weaken the timber seriously, both in reducing the effective section of the beam, and in causing the fibre to be curly and cross-grained."

"While age does not weaken the timber itself, it weakens it by season-checking."

The paper contains very valuable and pertinent information as to the quality and characteristics of bridge timbers of the kinds examined. Also a report of Mr. A. J. Hart on Douglas fir.

The principal average results obtained in the three sets of tests, made respectively at West Milwaukee, Minneapolis, and in the territory of Washington, are as follows:

a. Results from forty full-size transverse tests of bridge stringers made at West Milwaukee shops, April, 1889, by Mr. George Gibbs, mechanical engineer, of which 30 stringers were of white pine and 10

stringers of Norway pine, and of which 14 were new stringers selected indiscriminately from accepted stock, and 26 were bridge stringers that had been in use from 3½ to 8½ years:

Ultimate breaking extreme fibre stress in pounds per square inch, 2,350 to 5,376; average, 3,906.

Modulus of elasticity in pounds per square inch, 712,500 to 1,684,100; average, 1,123,090.

The range of results according to the age, kind, and section of stick is given in the tables accompanying the paper, and is very instructive.

b. Results from 14 full-size transverse tests of new white pine bridge stringers made at Minneapolis, December, 1889, by Mr. A. J. Hart, district carpenter, of which 7 stringers were from accepted stock, and 7 stringers from stock that had been rejected by the railroad lumber inspectors.

Ultimate breaking extreme fibre stress in pounds per square inch:

Seven accepted sticks, 3,162 to 5,131; average, 4,140.

Seven rejected sticks, 2,160 to 4,178; average, 3,248.

Average of all 14 sticks, 2,160 to 5,131; grand average, 3,694.

c. The results from 12 full-size transverse tests of Douglas fir bridge stringers, made by Mr. A. J. Hart, at the mills in the territory of Washington, March, 1890, have been mentioned above in Appendix N. Of these sticks 9 were new timber, 2 had been in use for 3 years each, and 1 for 6 years. Mr. Bates sums up the results as follows:

Ultimate breaking extreme fibre stress in pounds per square inch:

All 12 tests, 3,597 to 7,544; average, 5,791.

Omitting a very old and dry stick, that had been in use 6 years, and also a green stick of very poor quality, the results of 10 tests were 5,268 to 7,544; average, 6,214.

APPENDIX S.

COMPARATIVE TRANSVERSE TESTS OF FULL-SIZE OLD AND NEW WHITE PINE BRIDGE STRINGERS, MADE BY MR. W. H. FINLEY FOR THE CHICAGO AND NORTHWESTERN RAILWAY.

Mr. W. H. Finley, engineer of bridges, Chicago & Northwestern Railway, published in *Engineering News* of May 23, 1895, also in *The Railway Review* of June 1, 1895, the detail results of full-size comparative transverse tests of old and new white-pine bridge stringers, made at West Chicago shops, April 18, 1895.

There were 12 pieces of old stringers from the 85 foot covered Howe truss span, erected over the Fond du Lac river, Wisconsin, in 1864, and taken down in March, 1895, hence representing timber 31 years in actual use.

Results from the 12 pieces were as follows:

Ultimate breaking extreme fibre stress in pounds per square inch, 5,139 to 10,616; average, 7,051.

Modulus of elasticity in pounds per square inch, 715,000 to 1,900,000; average, 1,208,250.

For comparison two 10 inch by 10 inch sticks were selected from the stock of new white pine in the railroad company's lumber yard at West Chicago. The sticks were well seasoned, and above the average in quality. The results were as follows:

Average ultimate breaking extreme fibre stress in pounds per square inch, 5,402; modulus of elasticity in pounds per square inch, 982,500.

Mr. Finley remarks that these tests confirm the conclusions reached by Mr. Onward Bates in the similar tests conducted by him (see Appendix R), namely:

"Green timber is not as strong as after it is seasoned."

"Age and use do not weaken the timber. It preserves its strength until weakened by decay."

APPENDIX T.

TESTS OF DOUGLAS FIR AND CALIFORNIA REDWOOD MADE FOR THE SOUTHERN PACIFIC RAILWAY BY MR. JOHN D. ISAACS.

Mr. John D. Isaacs, assistant engineer, Southern Pacific Railway, summarizes the results of tests made under his direction as follows:

"Regarding strength of Oregon pine (properly Douglas fir) and Redwood timber, the following are the averages of many experiments (neglecting abnormal results) made several years prior to 1895, by our company under my supervision."

Ultimate Breaking Strength in pounds per square inch.

	Douglas Fir.	Redwood.
Tensile	15,900	8,000
Crushing	6,000	3,000
Shearing parallel with grain	600	276
Modulus of elasticity	1,272,000	600,000

Allowable Safe Unit Stresses in pounds per square inch.

Used in practice under ordinary conditions, by Mr. Isaacs.

	Douglas Fir.	Redwood.
Tensile	1,600	800
Crushing	1,200	600
Shearing parallel with grain	150	50
Bearing perpendicular to grain	400	150

"In trestlework red wood is principally used for sills, posts, and caps, or wherever the timber is subject to rapid decay, although creosoted fir timber has been replacing red wood for the latter purpose on the Southern Pacific railway system.

"The tests were made as follows: A large number of logs were cut from different portions of trees from various localities and exposures.

After air-seasoning the logs were cut into 1 inch square pieces; half of the pieces from each section were tested by tensile and the other half by compressive strain, the pieces being turned down to a round for about 8 inches in length. All pieces were tested, except such showing sap or splits running across the grain. The diameters were gauged very carefully. The machine was a home-made apparatus of about 25,000 pounds capacity, with a pressure gauge for recording pressures. The shearing tests were made by pulling a half-inch round out of some of the one-inch pieces. The modulus of elasticity was determined by bending pieces of various dimensions.

"All of the experimental results have been checked at various times by isolated experiments. An extended experience with a great variety of timber structures has confirmed my opinion that the units given above are just right for good practice.

"While the testing methods, as compared with more efficient laboratory machines, may appear somewhat crude, the results obtained are probably just as near the truth, considering the varying characteristics of different pieces of the same species of timber."

APPENDIX U.

PROFESSOR WING'S FULL-SIZE TRANSVERSE TESTS OF DOUGLAS FIR.

Professor. Charles B. Wing, Leland Stanford University, California published in *Engineering News* of March 14, 1895, an account of the methods used and results obtained by him in a series of full-size transverse tests of Douglas fir. None of the specimens were selected for testing. The timber was ordered from a San Francisco lumber yard, and would probably rate as a poor lot of "No. 1 Merchantable." The sticks contained considerable sap. Some of the sticks failed by shearing along the fibre parallel to the length of the specimen (see Appendix "F.-b."). Professor Wing states that it was noted that knots, even when sound and tight, weakened the stick by decreasing the section, and by causing the fibre to be cross-grained and curly, easily crushing when in compression.

The ultimate breaking extreme fibre stress in pounds per square inch obtained from ten sticks, each 6 in. x 10 in. x 17 feet long, was 4,590 to 7,951, average 6,293. The stick giving the limit of 4,590 was a stick that would have been culled in an ordinary lumber inspection. Excluding this stick the results ran from 5,580 to 7,951, average 6,482.

An additional series of ten tests was made with pieces 3 in. x 5 in. x 4 ft. 3 in. long, cut from uninjured parts of the large sticks that had been previously broken. The results showed ultimate breaking extreme fibre stress in pounds per square inch, from 6,438 to 12,056, average 9,257. The stick giving the lowest limit had a knot through the center. Excluding this the lowest limit was 7,960.

APPENDIX V.

MR. A. L. JOHNSON'S FORMULA FOR TIMBER COLUMNS.

Mr. A. L. Johnson, civil engineer, in charge of physical tests of U. S. Fo estry Division under the direction of Prof. J. B. Johnson, of Washington University, St. Louis, Mo., with the consent of Dr. B. E. Fernow, chief of forestry division, has kindly contributed the following

formula for timber columns, which is exceedingly valuable, not only as being the latest contribution on the subject, but especially as it is based on unpublished actual full-size tests made at Washington University. supplemented by a critical study and examination of previous full-size column tests.

Mr. Johnson writes on September 13, 1895, as follows:

The formula was obtained by plotting the tests of full-size beams, and is as follows for timber columns with square ends (but not for fixed ends):

$$f = F \times \frac{700 + 15c}{700 + 15c + c^2}$$

where f = ultimate breaking unit crushing stress on long column;
c = ratio of length to least cross-sectional dimension $\left(\frac{z}{d}\right)$;
F = ultimate breaking unit crushing stress on short column.

Mr. Johnson recommends the following values for F, those for American white oak, long-leaf pine, short-leaf pine, white pine, and cypress being obtained from recent tests of the U. S. Forestry Division, the other values being compiled from the best information available:

Ultimate Breaking Crushing Stress for short columns in pounds per square inch.

American white oak	4,000	Red cedar	3,500
Long-leaf pine	5,000	California redwood	3,250
Short-leaf pine	4,200	Norway pine	3,800
White pine	3,500	Colorado pine	3,150
Bald cypress	3,375	Douglas fir	4,400

Mr. Johnson explains that all long-column formulæ, prior to the above one presented by him, are based upon the assumption that a "square-ended" column is practically a "fixed-ended" column, and hence half the length of the column is the length used for the theoretical investigations. In reality the so called square-ended columns in practice can hardly be considered as fixed-ended, in spite of the end fastenings, and hence the lateral deflection curve under compression will be a true continuous curve from one end of the column to the other, and that the theoretical deductions should be based upon the full length of the column.

Mr. Johnson considers his formula as of very nearly if not the true theoretical form, and the co-efficients are entirely empirical, based upon actual tests, hence its superior value to previous column-formulæ.

APPENDIX W.

MR. A. L. JOHNSON'S RECOMMENDATIONS FOR UNIT VALUES.

Mr. A. L. Johnson, civil engineer, in charge of physical tests of U. S. Forestry Division, under the direction of Prof. J. B. Johnson, of Washington University, St. Louis, Mo., with the consent of Dr. B. E. Fernow, chief of forestry division, has kindly contributed the accom-

panying table showing the values recommended by him for the ultimate breaking unit stresses of various kinds of timber. The values for American white oak, long-leaf pine, short-leaf pine, white pine, and cypress are obtained from results of the tests conducted since 1890 by the U. S. Forestry Division, and hence can be considered as authoritative advance information as to the best average values shown by these tests, t e test results for all the species mentioned, excepting for long-leaf pine, not having been published up to the present time. The values for the other species given in the table, of which the U. S. Forestry Division has made no tests, were compiled by Mr. Johnson from the best test data available, making due allowance for the fact that much of the data at hand w s based on smal -size tests. The units given in the table are for large-size sticks as used in practice.

The ultimate crushing strength across grain is taken as the stress, producing an indentation of three per cent. of the thickness of the compressed stick.

RECOMMENDED VALUES FOR UNIT STRESSES OF TIMBER. A. L. JOHNSON, OCTOBER, 1895. ULTIMATE BREAKING STRESSES IN POUNDS PER SQUARE INCH.

Species.		Modulus of strength at rupture in lbs. per sq. in.	Modulus of elasticity in lbs. per sq. in.	Relative elastic resilience in inch lbs. per cu. in.	Crushing strength endwise lbs. per sq. in.	Crushing strength across the grain lbs. per sq. in.	Tensile strength lbs. per sq. inch.	Shearing strength parallel to fibres lbs. per sq. in.
Long-leaf pine..	D	7,750	1,440,000	1.30	5,000	645	12,000	500
Short-leaf pine..	D	6,500	1,200,000	1.30	4,200	645	9.000	400
White pine.....	D	4.400	870,000	1.00	3,500	440	7,000	300
Norway pine ..		5.450	1,132,000		3,800	430		
Colorado pine..		4,900	888.000		3,150	540		
Douglas fir.....		6,600	1,380,000		4,400	500		
Redwood.......		7.200	452,000		3,250	345		
Red cedar......		5.000	670,000		3,500	750		
Bald cypress....	D	5.000	900.000	1.10	3,375	360	6,000	240
White oak......	D	6,000	1,100,000	1.25	4,000	1,200	10,000	800

NOTE. The values marked "D" were obtained from experiments made by the U. S. Forestry Division. The other values were obtained from various sources, chiefly from the tenth census report, but so modified as to give results comparable with the forestry division values.

These values are for eighteen per cent. moisture representing a half dry condition. For modifications of these values for other moisture conditions, and for fuller general description, see bulletin on "Timber Trestle Design," issued by the forestry division.

Moved and seconded that the report be received and included in the report of the proceedings. Carried.

Mr. Andrews.—The subject is now open for discussion, but if none of the members wish to speak on it, we will pass to the next subject.

Mr. Patterson.—Before passing to the next subject, would like to say that we have received letters of invitation, extending the courtesies to this association of the Louisiana Sugar and Rice Exchange, Cotton Exchange, and Board of Trade.

Mr. Cummin.—I move that these invitations be received, and that the secretary be instructed to respond to the gentlemen who so kindly extend the invitations to this association that, if our business permits, we will be most happy to avail ourselves of their kindness. Seconded and carried.

The secretary read communications from ex-President Hall, Mr. Quintine McNab, Mr. George J. Bishop, and Mr. J. H. Travis, regretting their inability to attend this meeting.

Mr. Shane.—I learn that Mr. McGonagle is unable to attend on account of the death of his father, and move that the secretary be instructed to express to him the condolences of this association. Seconded and carried.

Reading of the letter from Mr. McGonagle by the secretary.

No. 7.—Span limits for different classes of iron bridges and comparative merits of plate girders and lattice bridges for spans from 50 to 110 feet.

Mr. Andrews.—Mr. McGonagle is chairman of this committee, which simply reports progress.

Mr. Berg made a motion that the committee be granted an extension of time until next year. Seconded and carried.

No. 4.—Best method of erecting plate-girder bridges. Postponed to afternoon session.

No. 5.—Best and most economical railway-track pile driver.

Mr. White.—Owing to pretty hard work on my part during the past year I have not investigated this subject as I should,—in fact, scarcely at all,—and beg for an extension of time. I promise that I will do better. Moved and seconded that further time be granted. Carried.

No. 6.—Sand dryers, elevators, and methods of supplying sand to engines, including buildings.

Report read by Mr. Aaron S. Markley.

DANVILLE, ILL., October 10, 1895.

To the President and Members of the American International Association of Railway Superintendents of Bridges and Buildings:

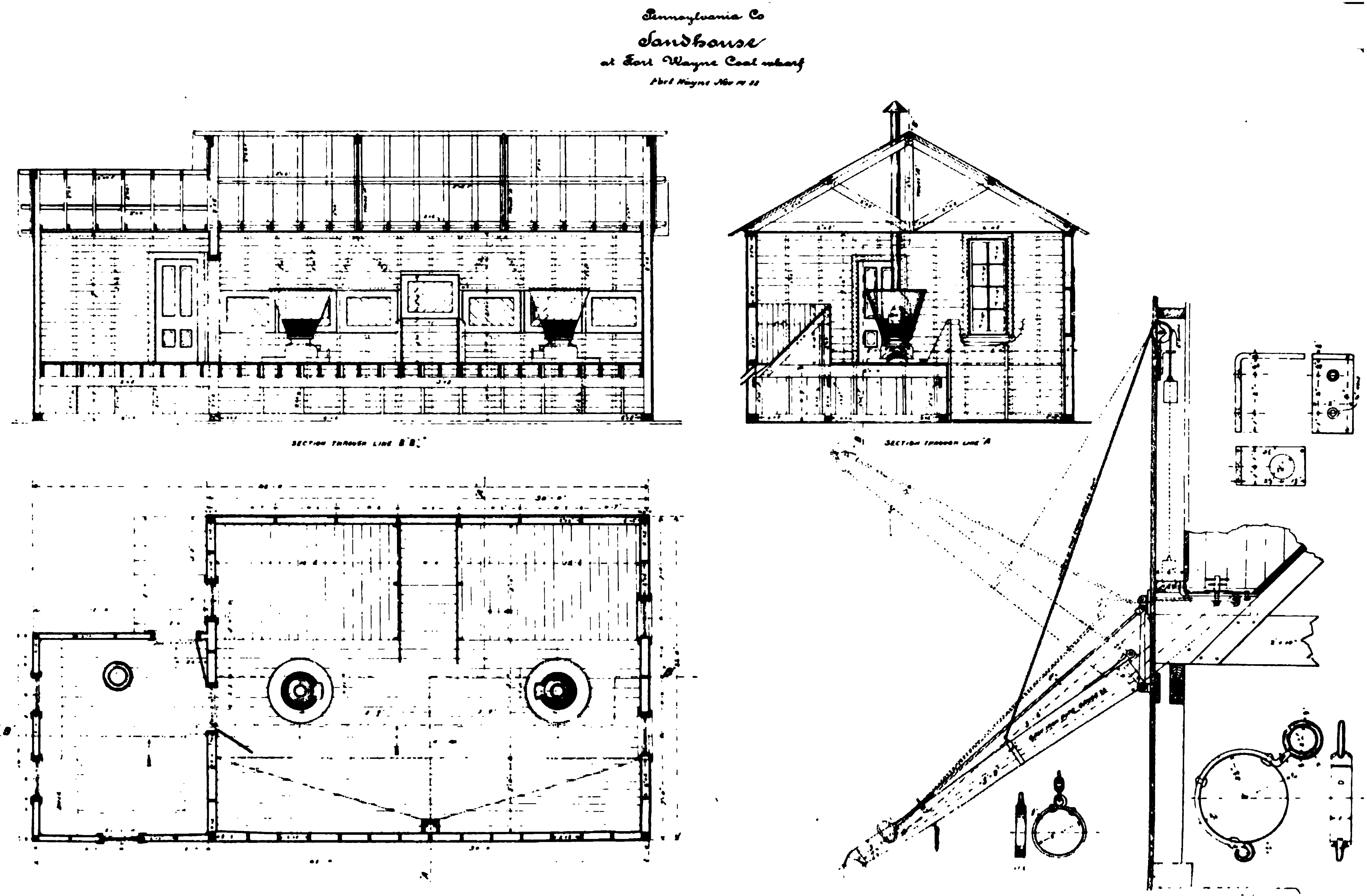
Your committee appointed at the last annual meeting held in Kansas City, Mo., October, 1894, on subject "Sand Driers, Elevators, and Method of Supplying Sand to Engines, including Buildings," makes the following report on subject assigned it:

On April 20, 1895, a circular letter was sent out to many members of this association, civil engineers, superintendents of motive power and machinery, and editors of railroad journals. Many of them responded to them by letters, and others by both letters and blue prints, for which the thanks of the association and the committee are due, for the assistance rendered it in making its report. Some of these blue prints contain a large amount of detailed information which will be instructive to those that desire to avail themselves of their contents.

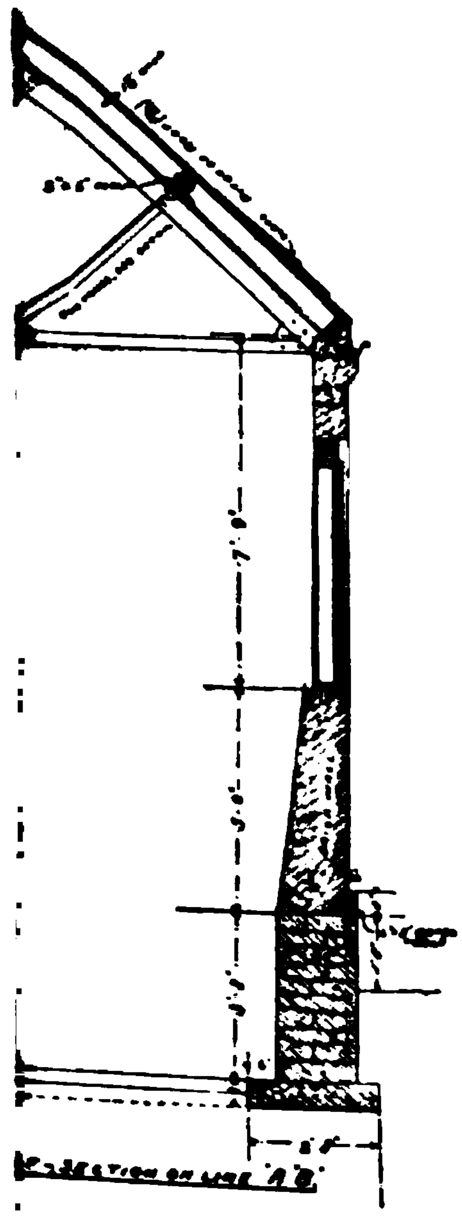
It was quite apparent that it would be impossible for your committee to recommend any standard plant for general purposes throughout the country. The amount of sand used at any given point will largely depend on the character of the plant that should be erected and amount to invest, but the committee has no hesitancy in recommending that wherever the amount of sand used justifies the establishing of a sand drying plant. No railroad company can afford to do without an elevated dry-sand hopper, so sand can be taken same as water. The additional expense will not exceed one hundred dollars. To supply engines with sand with buckets, as is done in many cases, requiring one to two men in addition to engine man, is dispensed with, thus saving the expense of two men which consumes in sanding each engine from eight to ten minutes time. The saving in this direction is apparent on an investment of one hundred dollars, as well as the liability of the men dropping sand on guides, etc., of the engine when supplying sand to same with buckets, which at times is unavoidable. With the elevated hopper one man can do the work of three men. At places where the expense of elevating the sand by machinery is not justified, the man that attends to drying the sand with a windlass and self-dumping bucket can elevate sand at leisure times, sufficient to supply twenty-five to thirty engines per day. In connection with this work, if engine supply of waste and oil is close, he can also attend to these supplies.

The Chicago & Eastern Illinois R. R. has similar arrangements to the above referred to at Momence Junction, Ill., which is handled in this manner by one man at a dollar and twenty-five cents per day, the entire plant costing complete less than four hundred and seventy-five dollars, including wet-sand bin with a capacity of twenty carloads of sand. In all cases in cold country the green-sand bin should be large enough to hold the entire winter supply where it is possible, in order to save the expense of unloading frozen sand from cars. The hopper should be of sufficient capacity that when filled will supply the demand during the night.

At terminals where a large quantity of sand is consumed, and where air and steam are utilized for other purposes as well, the former can be used for elevating the sand much cheaper than by elevator. The greater part of this expense will be the air supply requiring no other machinery to maintain. In the use of air all pipes so used should be under cover, and any moisture that accumulates in the air pipes while not in use can be eliminated by running the air through them before sand is started. The committee is not in possession of sufficient data



Sand Plant, P., F. W. & Ch. R. R., at Fort Wayne, Ind.



ines west .

to recommend drying sand by steam radiation, though there are a number of them in use. Blue prints are submitted to this convention, describing that method of sand drying for your information. The objections the committee has to offer for its use for this purpose, being in its natural form is in itself damp, whether the dampness from the sand and steam would not deter the sand from drying as readily as it should, more particularly where dried in large quantities, the steam and wet sand causing and containing moisture which could not pass off readily in the open atmosphere without first passing through at least part of the sand. Where steam is used for this purpose, the boiler supplying it should be located as near the sand dryer as possible, that the steam passing through the coils may be as dry as possible, thus reducing the dampness to a minimum.

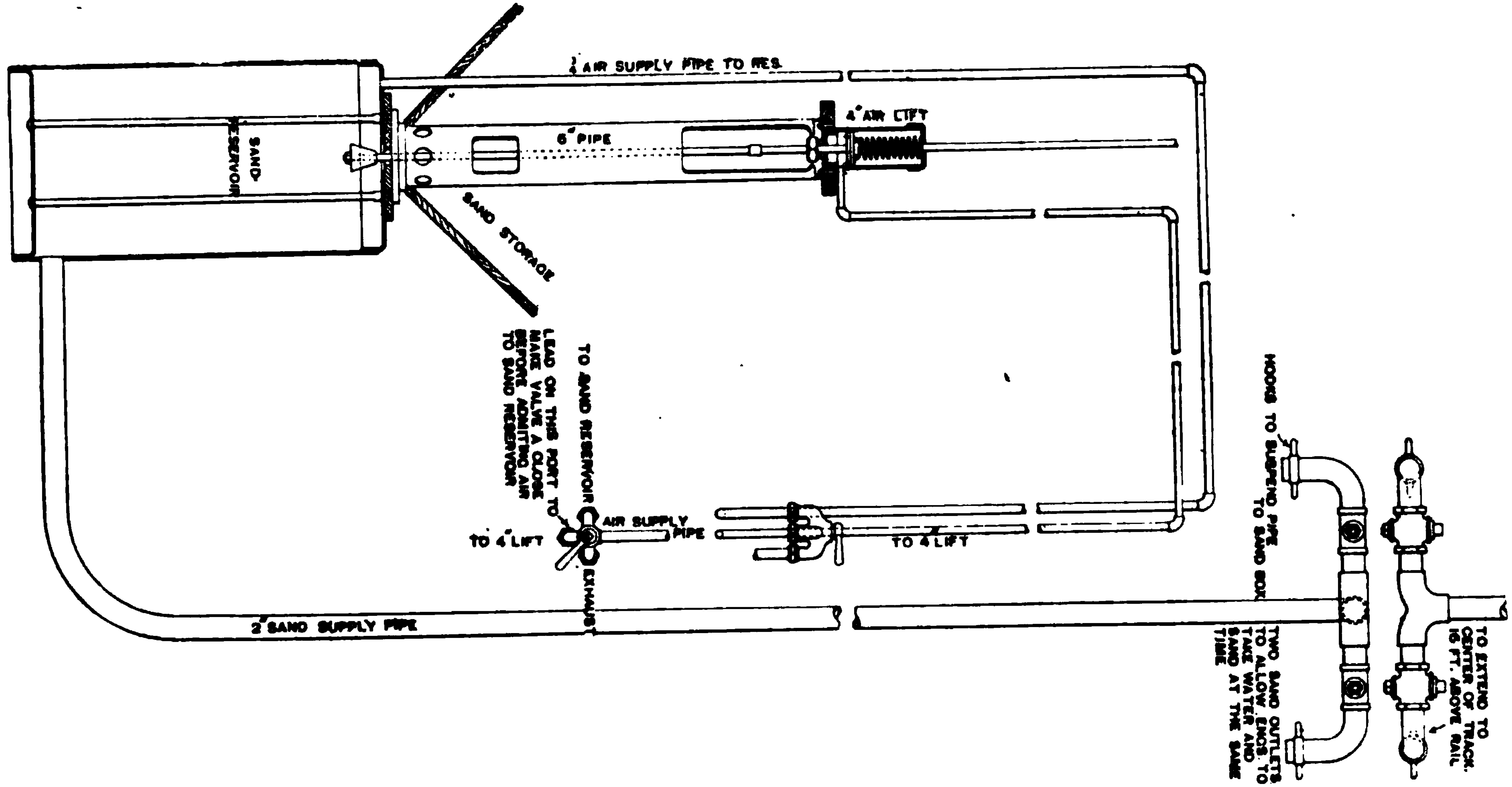
Another objection is the cost of maintenance, which in the committee's opinion, would far exceed that of the ordinary stove that is used for that purpose. The repairs on the former must be done with skilled labor, while the latter can be repaired with common labor. One ordinary sand drying-stove will in ten hours dry enough sand for fifty to fifty-five engines, as much as is usually required at one terminal of ordinary sized road in that length of time or twenty-four hours. The character of the building should be fire-proof in every particular, and so located that sand can be taken in connection with coal, water, and oil on the same track, either going to or coming from the engine-house where possible. A large per cent. of labor can be saved where green sand track can be elevated. By this means gravitation can be used, which will reduce the cost to the minimum.

SAND PLANT OF THE PITTSBURGH, FT. WAYNE & CHICAGO RAILWAY AT FT. WAYNE, INDIANA.

Frame building, 22x30. Elevated 11 feet 8 inches above main track. Two bins for green sand, 12 feet 6 inches by 9 feet. Immediately opposite these bins are two sand-drying stoves, and opposite stoves are hoppers for dry sand. Building is so arranged with elevated coal track on one side to unload green sand into bin from car and track on opposite side for engines to take sand from. Dry sand hopper five feet wide, 30 feet long, and four feet high, floor of which inclines towards outlet spout to engine. Floor of green sand and drying sand department are on same elevation from which dry sand is shovelled into dry sand hopper, thus dispensing with the expense of elevating dry sand by machinery.

SAND PLANT OF THE PENNSYLVANIA COMPANY, SIXTEENTH STREET, CHICAGO, ILL.

Building located on level with main track, 32 feet long, 14 feet wide, built of brick, with stone foundation. Truss over main building of iron and covered with slate. Tower for elevator 29 feet and two inches above foundation, 15 feet, 8½ inches of upper section of iron, in which dry-sand hopper and upper elevator attachment are located. Sixteen and one-half feet of one end of this building used for storing green sand, and remainder used for drying stove and hoisting engine. The hoisting engine being run by compressed air supplied by Westinghouse compresser located 300 feet away, which also furnishes air for coal hoist and pressure for oil tank. Elevator located near sand-



Sand plant at West Philadelphia. (Courtesy of American Engineer and R. R. Journal.)

Sand Plant, P. & W. R. R., at Painesville, O.

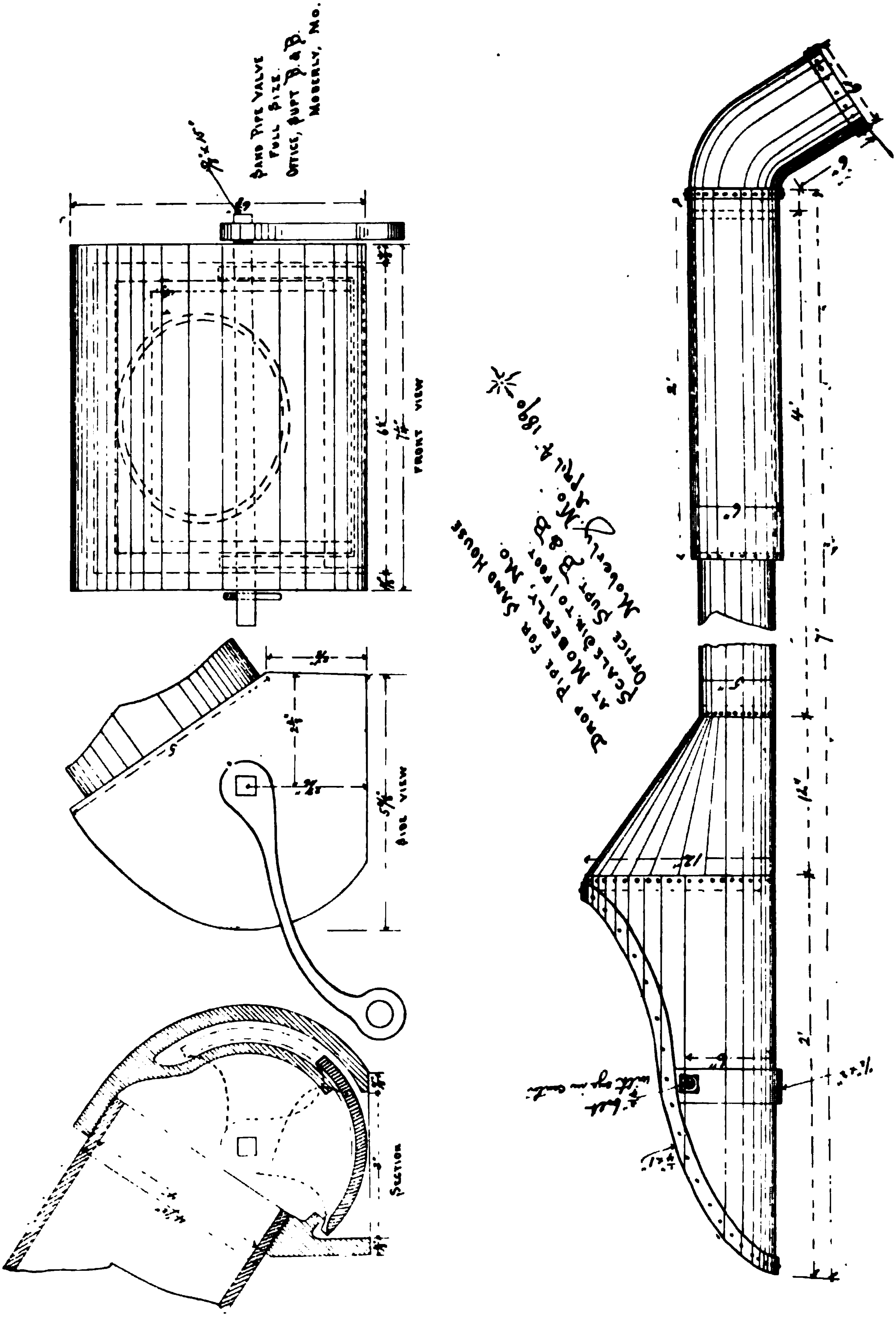
drying stove where dry sand is shovelled direct from floor around stove to boot of elevator. Elevator shafts 24 feet on centers. Hopper for dry sand 4 feet high, 7 feet wide at top, 6 feet 3 inches long, bottom of which is inclined towards outlet spout at an angle of 35 degrees. In both of the above plants sand is taken in the same manner as water, with number 22 galvanized iron spout 6 inches in diameter at the butt and 4 inches in diameter at the outer end, 5 feet 9 inches long. Sand valve operated by lever which is nearly same length as spout to which it is looped at the outer end. By this means spout and lever is raised and lowered at same time by chain and weight attachments.

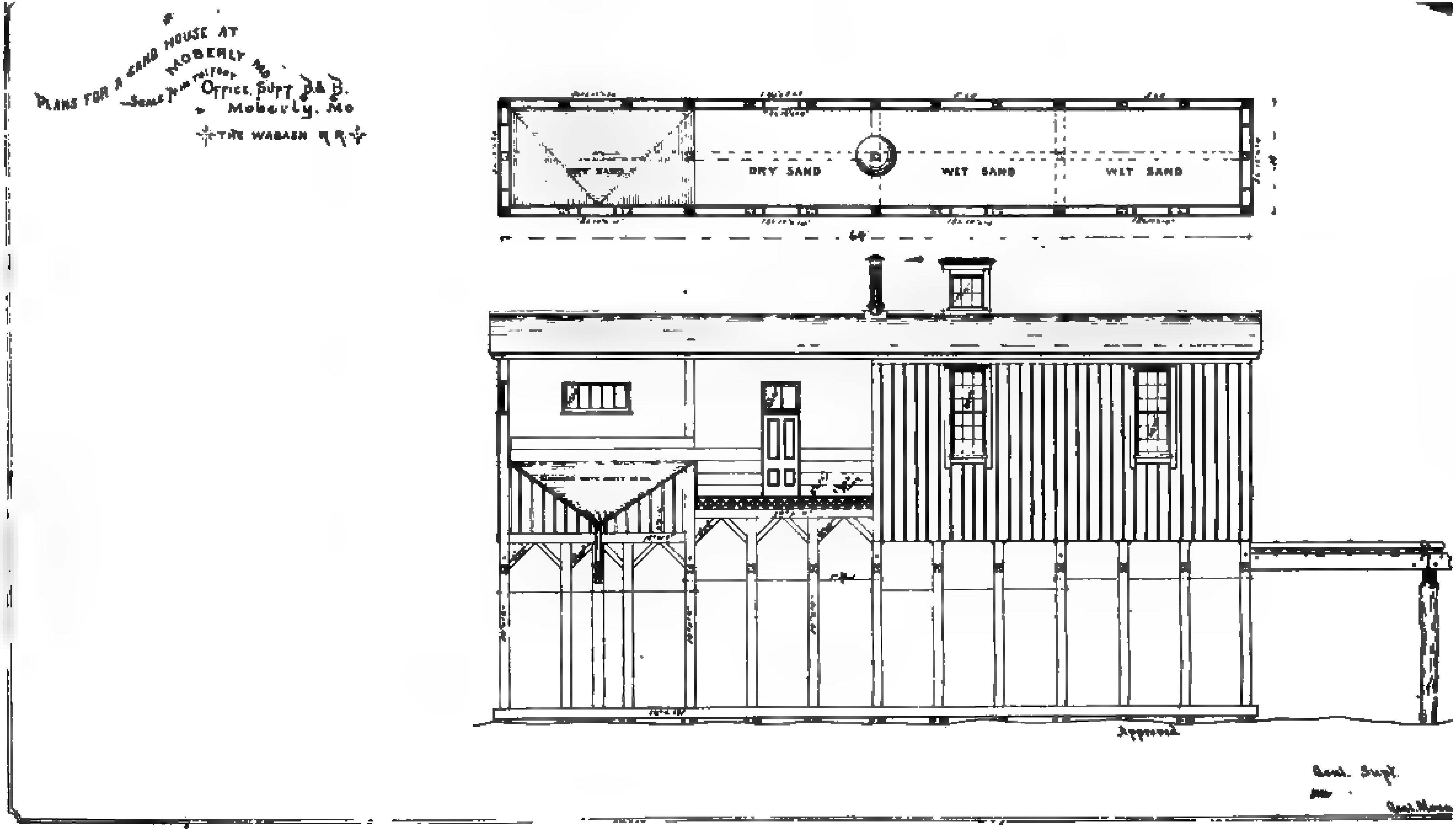
Mr. N. W. Thompson, superintendent B. & B. P., F. W. & C. Railway, reports as follows: Blue prints showing this system in use on his road. "At Ft. Wayne the sand house is located at the coaling yard, which is elevated on natural ground 11 feet 8 inches above main track rail. The sand is shovelled from cars into wet sand bins through doors at the back of the building, from there it is shovelled into the drying hopper, which is nothing more nor less than a heavy wire surrounding a so-called No. 1 common stove heated with bituminous coal, the sand as it dries falls upon the floor and is shovelled into a hopper to which is attached a movable spout which supplies the sand direct to the engine sand boxes, as shown by blue print.

"At Chicago the arrangement is somewhat different, as the tracks are all on the same level. The sand is shovelled into wet sand bin, as is done at Ft. Wayne, thence to the drying stove, the dry sand being shovelled into a hopper, and by means of a conveyor is elevated to another bin from which a movable spout leads to sand box of engine, as at Fort Wayne. The power to run conveyor is taken from a small (about ¾ horse power) engine, operated by compressed air drawn from storage track, also shown on blue print. The air storage tanks are kept supplied from Westinghouse compressor located in our electric light plant about one block away. As to the cost of these sand-drying plants and of operating them I am unable to give the figures, not having access to the same."

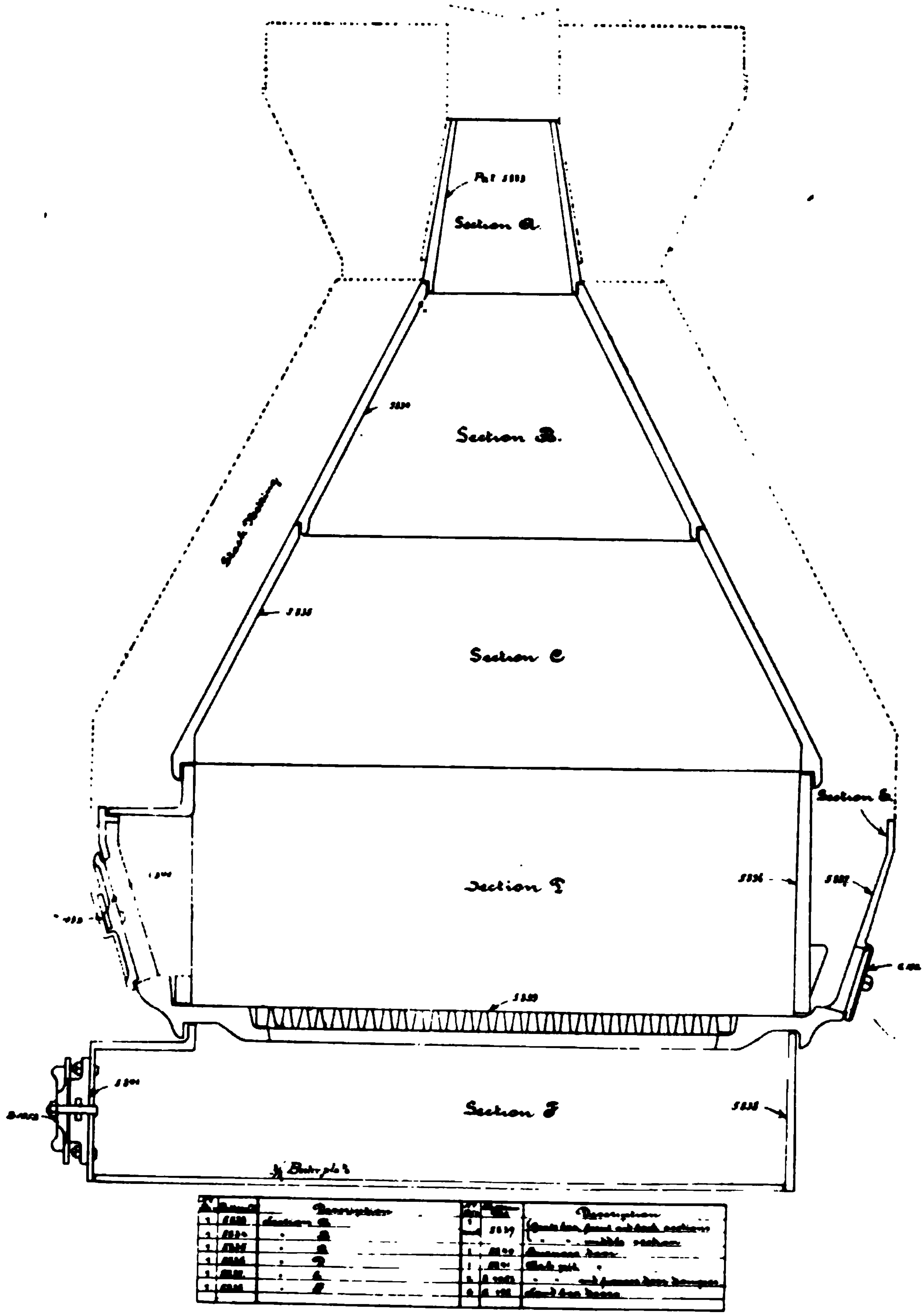
SAND PLANT OF PITTSBURGH & WESTERN RAILROAD, AT PAINESVILLE, OHIO.

Sand loaded in cars run on elevated track sixteen feet above main track from where sand is shovelled into green sand hopper. Under the centre of this hopper, drying stove is located using six inch gas pipe for smoke-stack, around which sand is thrown, and runs by gravity from this hopper into top of sand drying stove. After sand is dried, it is run by gravity to boot of elevator through spout, in the bottom of which is fine screen through which sand passes, in connection with which is a diverging spout which carries off coarse screening to outside of building. Elevator belt made of eight inch two-ply rubber belting, riveted to which is one pint malleable iron buckets, three feet centres, run by four horse power upright engine connected with six inch belt to main shaft of elevator. Driving-pulley on engine twelve inch, on main shaft, twenty-four inches; upper and lower elevator pulleys, thirty inch diameter. Centre to centre of elevator shafts, thirty-five feet three inches. Dry sand bin from which engines take sand located on opposite side of elevated track, sand being elevated over elevated track. Building occupied by this plant, of frame and under cover, adjoining coal dump on the end. Building, thirty-six feet long, thirty-four feet wide, through centre of which elevated track passes. Valve for dry sand bin, of cast-iron sliding wrought plate, eight inches wide, twenty inches long, with three inch hole for outlet of sand into outlet spout of engine.

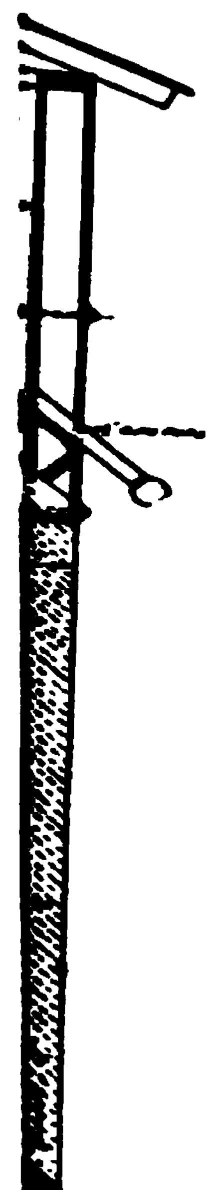

Sand Pipe Valve
Full Size.
Office, Supt. B. & B.
Moberly, Mo.
Front View
Side View
Section
Drop Pipe for Sand House
at Moberly, Mo.
Scale 3 in. to 1 foot.
Office Supt. B. & B.
Moberly, Mo. April 4. 1890.



Sand Plant, W. R. R., at Moberly, Mo.



Sand Dryer, C., B. & Q. R. R., at Aurora.



SAND PLANT LOCATED AT MOBERLY, MO., ON THE WABASH RAILROAD.

Attached letter from Mr. James Stannard, superintendent B. & B. of that road, fully explains the design and operating of the plant, together with the cost of handling same:

"Elevated sand house which is located on elevated coal track at end of chutes. Cars of green sand are placed on end of elevated coal chute tracks and unloaded with shovels from cars into sand house. Our mode of drying is by use of large cast furnace, somewhat in shape of a stove with a hopper made of heavy wire netting. Hopper is kept filled with green sand which is passed in at top by use of shovels. We use coal for fuel in above furnace. Sand screen is placed between sand dryer and dry sand bin, through which dry sand is passed from sand dryer to bin. Sand bin is made in shape of hopper with valve located at lowest point, from which sand is passed through spout to sand dome on engine, on the same principle as water is taken from water tank. Capacity of dry sand hopper, about two carloads or twenty-four cubic yards. Time required for sanding engine, about two minutes. Capacity of green sand storage as per blue print is about seven carloads or eighty-four cubic yards. Man in charge of coal chute also has charge of sand drying. Cost per yard for handling and drying sand, about twenty-five cents per cubic yard. Size of building as shown on plan, ten by sixty-four feet; height from floor line to roof, sixteen feet. This plan has been adopted as our standard on Wabash line, and I consider same a very convenient, economical method of handling sand, there being no waste in handling."

SAND PLANT C., B. & Q. RAILROAD, WESTERN AVENUE, CHICAGO, ILLINOIS.

Mr. G. W. Rhodes, superintendent motive power of that road, in letter attached to committee, fully explains the operation of this plant, together with some practical experience he has had with sand-drying plants and their operation. Mr. Rhodes gives his reason from experience he has had in this direction which is certainly good evidence by which to be guided.

"Yours of the 27th ult. received, and we take pleasure in forwarding you to-day by Adams Express, two blue prints showing the sand tower and sanding device as in use on the C., B. & Q. You will observe that the sand is hoisted by an elevator, our buckets are secured to a leather belting—we formerly used a link belt, but it did not prove as satisfactory as the leather belting. The elevator can be operated by hand or by power. At our principal shops we operate it with power. A feature of the device is that the engines are sanded up from a spout when they are coaled and watered. We have experimented with various methods for drying sand, such as steam pipes, large, flat pans with steam introduced, ordinary stoves with an outside sheet-iron casting. We find in practice, however, that there is nothing as good as the large cast-iron stove as shown on sheet 1150, encased with wire netting. The advantage in using the wire netting is that as the moisture is driven off from the sand by the heat, it escapes at once through the netting into the atmosphere, and the sand is dried very much quicker, consequently, than if it was enveloped in a sheet-iron casing. I am not sure that our tower is the most economical device. We find, however, that it is very convenient, as at many points we are able to elevate sufficient sand during the day to supply the want at night without having to maintain any machinery in operation. At one of

our shops we elevate sand by air; the air being supplied by a couple of Westinghouse pumps. Other railroads, we understand, also elevate sand with air. Our experience, however, is that this is a very wasteful method. The coal consumed to furnish sufficient air for the work is very large and is produced quite expensively. A much less amount of steam and consequently a less consumption of coal to run a small engine which will operate an elevator as shown on the drawing."

SAND PLANT OF ATCHISON, TOPEKA & SANTA FÉ RAILROAD, LA JUNTA, COL.

Steam sand dryer and air elevator, elevating the dry sand direct from sand drum into engine sand box. In a letter from Mr. Drury, general foreman, in reply to one from committee in reference to delivery sand pipe being exposed to the weather, regarding dampness that might in all probability interfere with the free flow of sand, as follows;

"In reply to your favor of the 27th inst., relative to sand device, please refer to my typewritten letter accompanying blue print of the same I sent you some time ago. By that you will see that the air is admitted to top of drum. The small pipe at the bottom is used in case of two inch pipe stopping up as will be explained in letter referred to in regard to experience of trouble by sand becoming hardened—due to moisture. In the compressed air I had some difficulty, but overcame this by placing a siphon a short distance from the drum, in air line. This collected all the moisture, and before each application of air to drum I have my hostler open pet cock on siphon to allow any collection of dampness to escape. I find by doing this, and arranging to shut off air after application, I have no further trouble. In conclusion I would say that the sand device has got the capacity of ten cubic feet per minute. Hoping this will be of some interest to you and your committee."

Following is explanation:

(A) represents square drying box, in which are suspended coils, or loops of steam pipe at sufficient incline to insure proper drainage. The bottom of the box is of two and one-half by two and one-half mesh netting, trussed and suspended, admitting of a slight lateral motion to precipitate the dry sand, which, in falling, passes through an intervening screen of four by four mesh netting, set at an angle to carry off coarse gravel, the dry sand falling into hopper (B).

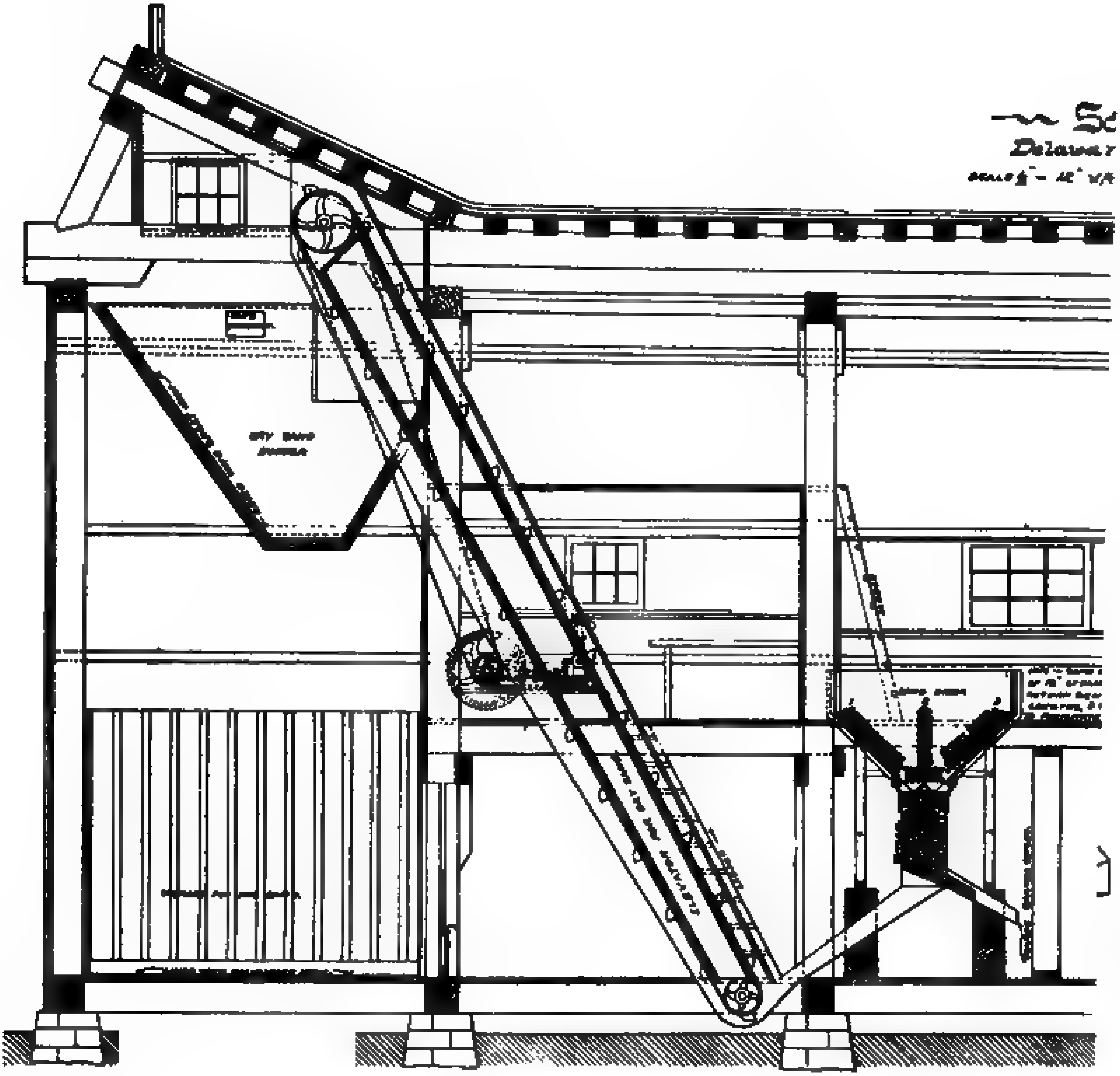
(D) is round storage drum of pressure strength, set in a pit cased with plank, and large enough to admit passing around it.

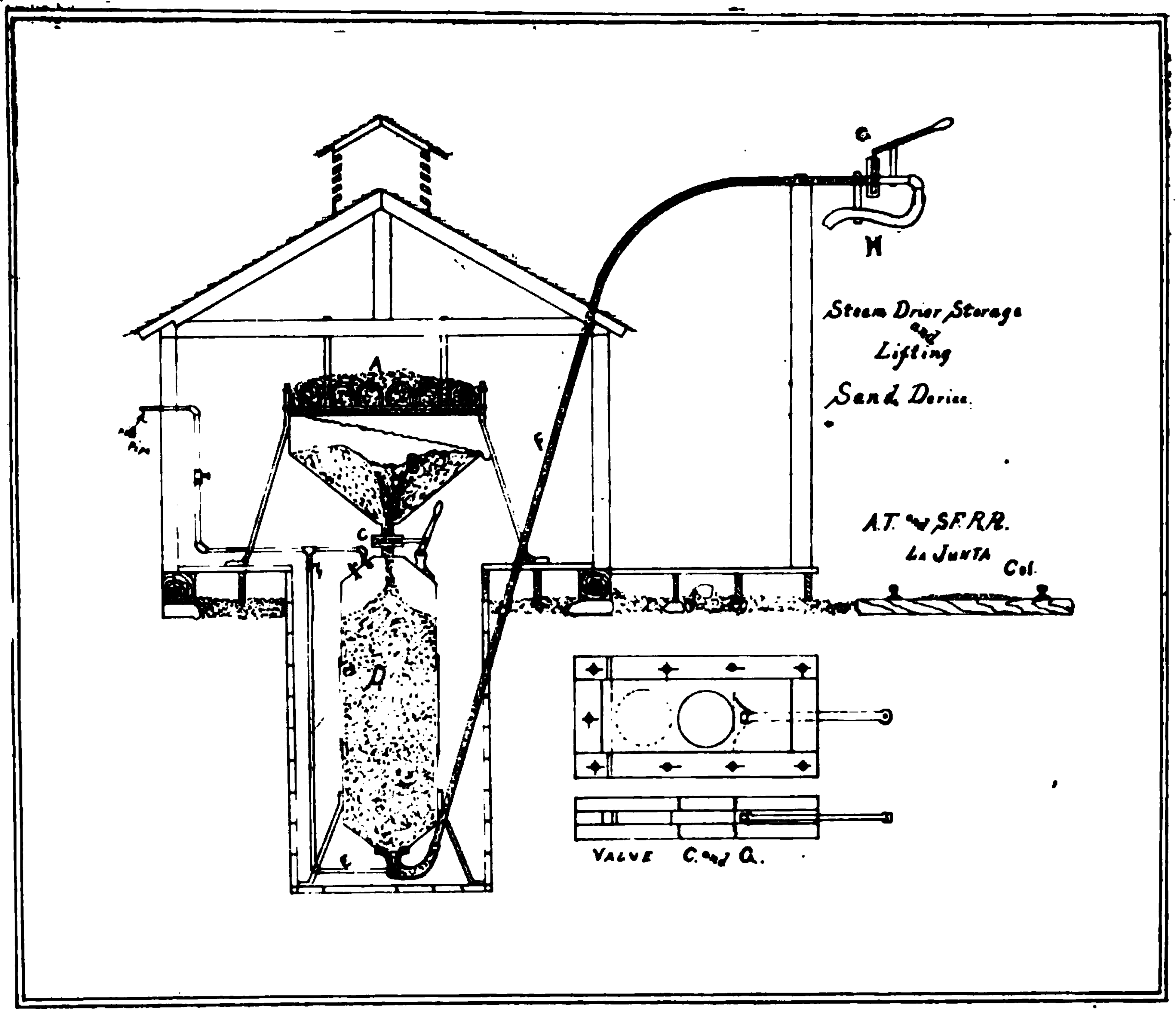
(C) is valve connecting (B) and (D).

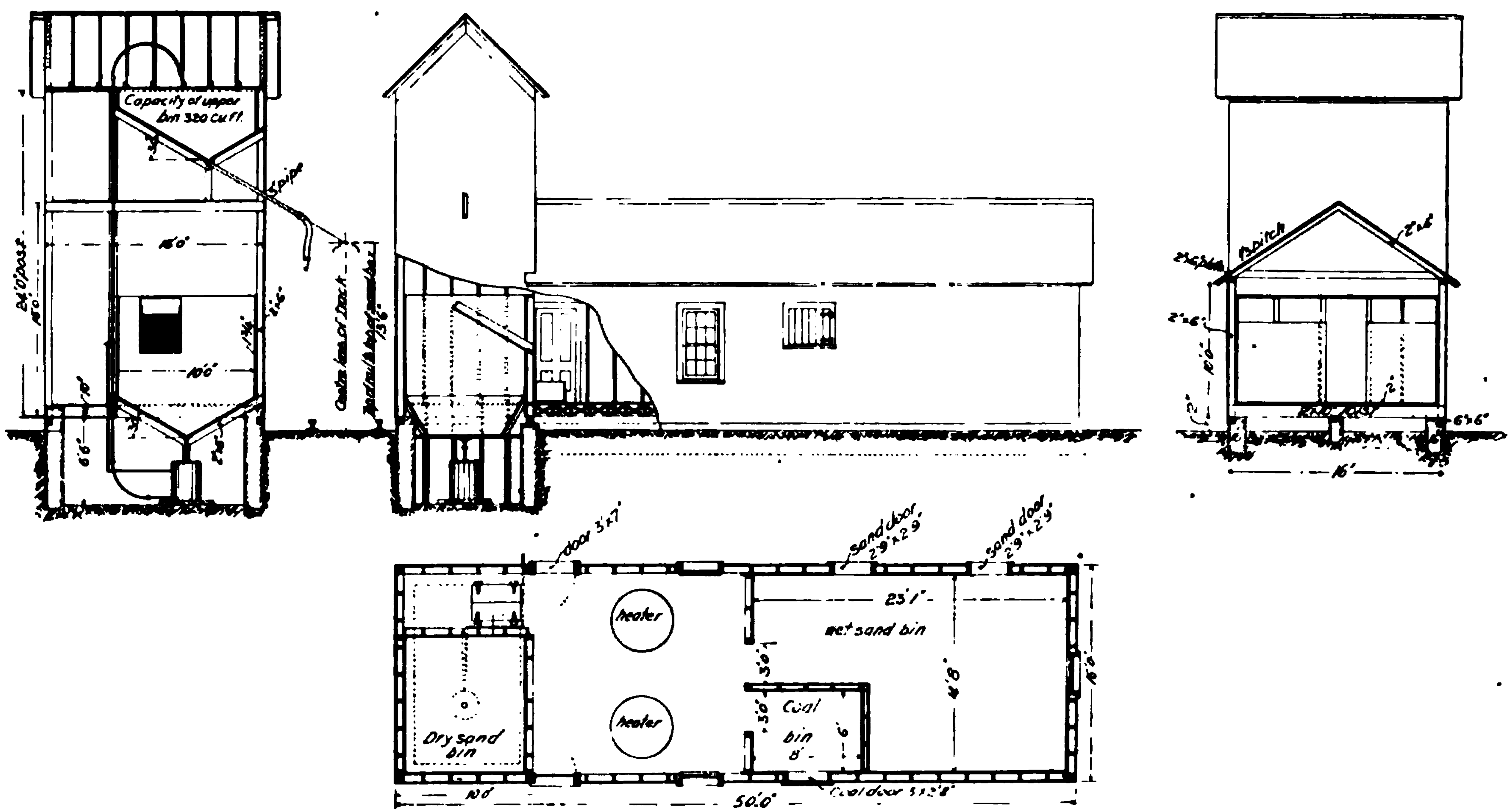
(F) is the delivering pipe. (G) the valve controlling flow of sand into engine box. To charge drum for operation, open release valve (X), on top of drum, relieving drum of pressure, then open slide valve (C), and fill drum with sand. Close (C) and (X), and open valve in air pipe. If sand does not flow freely at first, open valve at (Y), which admits air into (E). This acts as a primer or persuader, but is seldom used. (H) is a piece of hose, flexible, to lead sand into box of engine. With eighty pounds pressure, and a two inch pipe, this device will deliver ten cubic feet of sand per minute. With the exception of drum (D), valve (C) and (G), and pipe fittings, are all made of old material. Large sketch of valve (C) and (G) annexed.

SAND PLANT OF DELAWARE, LACKAWANNA & WESTERN RAILROAD, EAST BUFFALO, N. Y.

Steam and drying bin six feet wide at top, ten feet long, with vertical sides extending eighteen inches down from top. Below this, sides




Steam Drier Storage and Lifting Sand Device.
A.T. and S.F.R.R.
La Junta Col.
VALVE C. and Q.
A
C
D
E
F
G
H



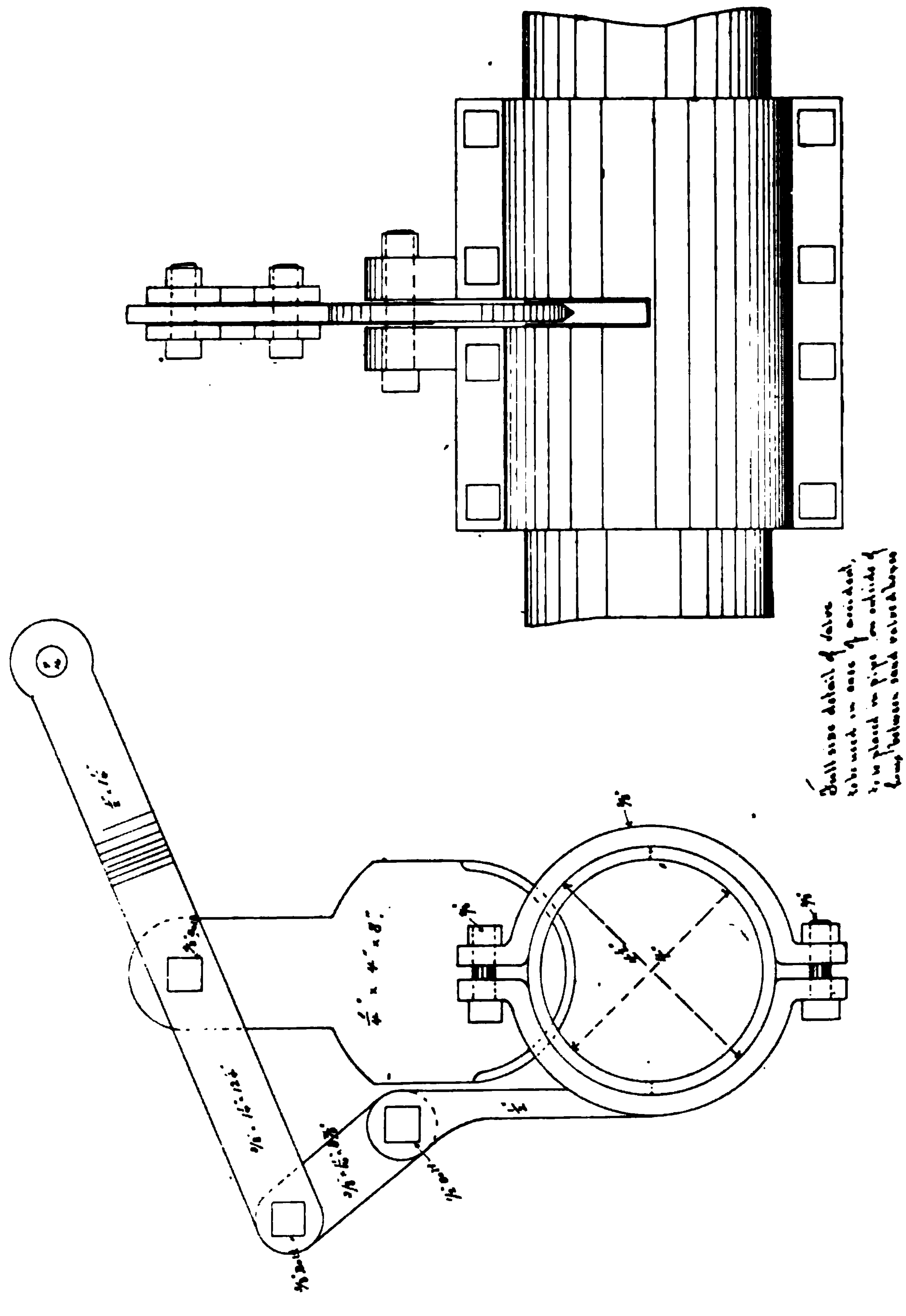
Sand plant A., T. & S. F. Railway. (Courtesy of Railway Master Mechanics.)

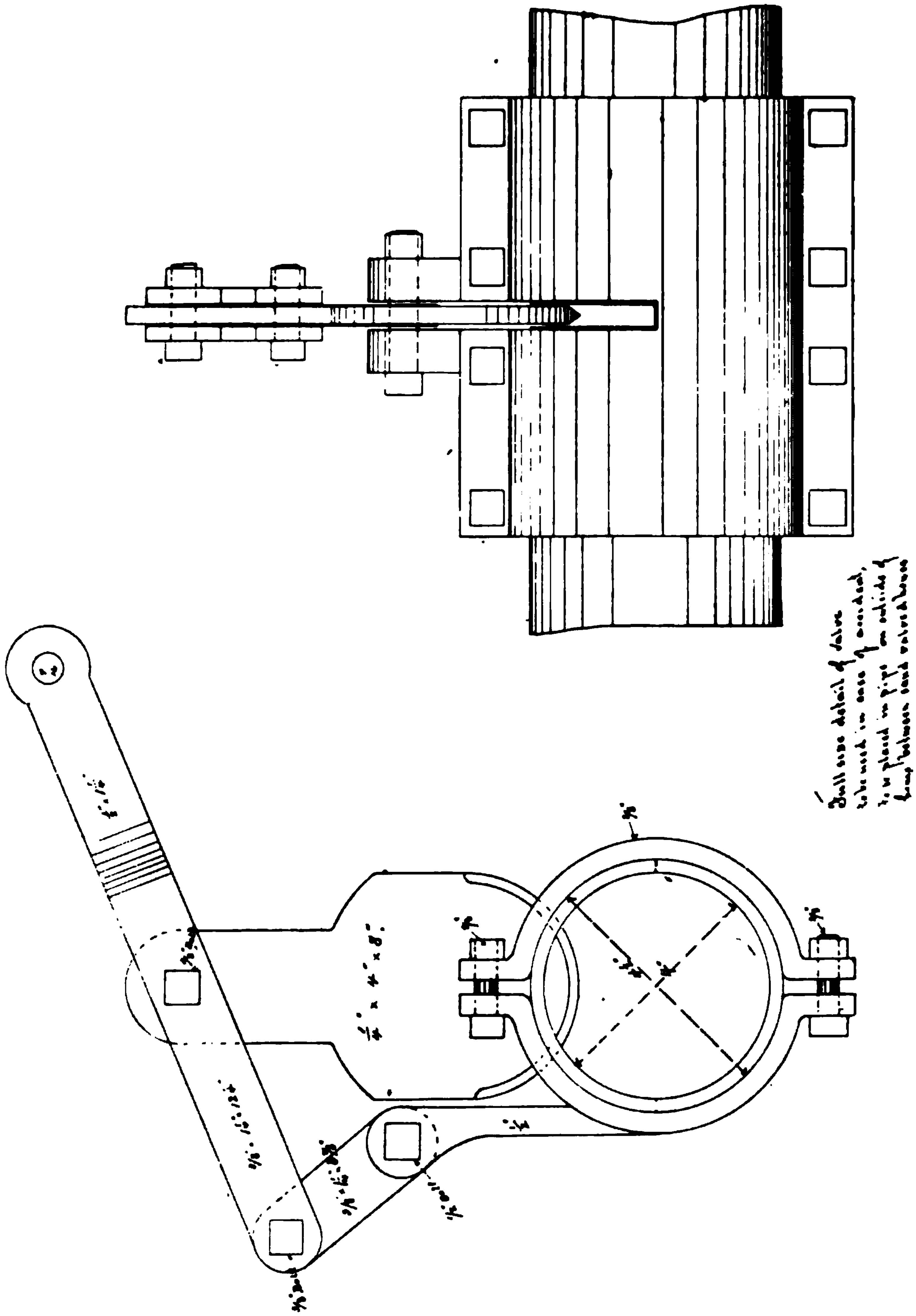
incline at an angle of forty-five degrees to bottom, leaving twelve inches flat surface on bottom, with necessary opening for dry sand to pass through, detail of which is not brought out in plan. Three sets of one and a quarter gas pipe along each side and bottom of hopper, as well as through centre of same, nine feet six inches long, with return bends, making 100 pipes on sides and bottom, and thirty-one in centre, making a total of 131 in all. Underneath sand drying hopper is suspended galvanized iron hopper, the top of which is full length of dryer, and twelve inches wide, reduced to twelve inches square at bottom. The hopper sheet is on the two ends only in which are placed screens for screening sand, leaving a space of about three inches between the screens and sides of hopper on the bottom, through which sand passes, leaving gravel to pass over the screen. Two outlet spouts are provided, one for gravel, which is diverted outside of the building, and another one for sand run by gravity to boot of elevator, where it is elevated into sand hopper, from which engines are supplied. The entire plant is eighteen feet wide, sixty-two feet long, twenty-five feet in length of which is used for green sand, twelve feet for sand drier, and the remainder for elevator and hopper, as well as dry sand storage bin, which is located underneath the hopper. Track elevated twenty-seven feet, where cars loaded with green sand are run and unloaded from drop-bottom cars through doors provided for that purpose in centre of track. The bottom of green sand bin being elevated eleven feet above the track or ground surface, or sixteen feet below base of rail of elevated tracks. Top of sand drier hopper elevated eighteen inches above green sand bin floor. The outlet valve in bottom of dry sand hopper is entirely different from any of the others submitted, being cone-shaped, run to a point in a vertical position, and is inserted into the outlet spout inside the bin when desired to stop the flow of sand, and is operated by lever attachments inside, and from the top of the bin, with suspended chain on outside, in easy reach of engine man. Outlet spout three inch galvanized iron, telescope pattern, suspended by weight attachment at outer end.

SAND PLANT OF MISSOURI PACIFIC RAILROAD.

Sand drying house, 28 by 34 feet. Sand, after being dried in stove and furnace, is placed in round storage drum-pressure strength, which is located near drier or furnace, the top of which is on level with the floor of sand house and encased with brick walls. The air is applied in top of drum from compressor; the sand supply pipe from drum to sand bin is also connected to top of air drum and extends to bottom of same. Air being supplied to top of sand in drum, forces sand from drum to dry sand bin, which is located on opposite side of track, from which engines take sand in same manner as they do water. Mr. Peck says, on inquiry from the committee, that so far as his information goes they have never had any trouble with air pipe stopping up with sand, or accumulation of moisture in them. Men who operate these conveyors and elevators say they give the best of satisfaction in every particular. Mr. R. M. Peck, superintendent B. & B., reports as follows:

"In reference to handling sand, drying same, and delivering it to engines, will state that we use two methods of drying sand, one by stove and the other by furnace. Enclosed to you blue print of drawing of furnace. The stove we use is Clark's patent. Also enclose blue print of sand-drying house in use. We are using two methods of delivering sand to our elevated bins, which we built in connection



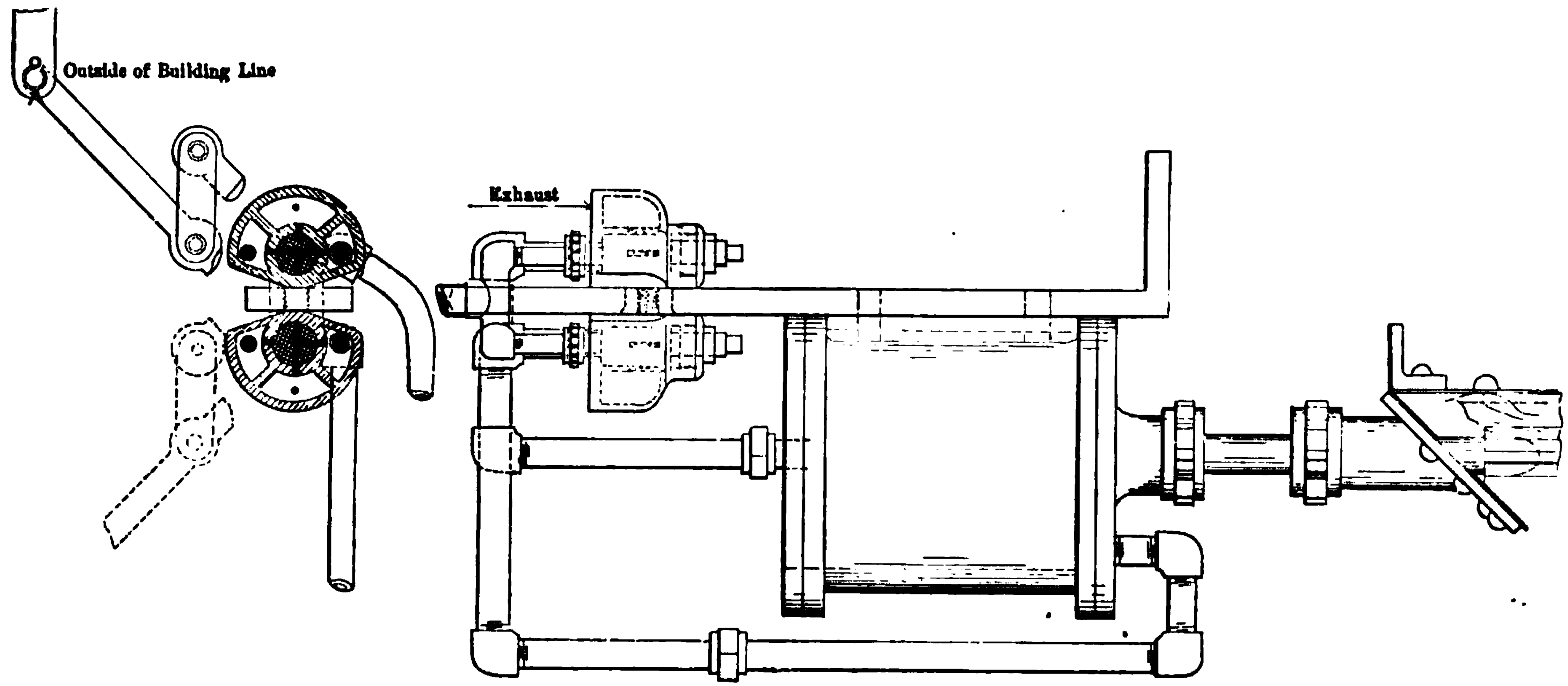


with our coal chute and elevated track, from which we can spout sand into the barrel of our engines. At some of our stations we switch our sand cars up on our elevated tracks and shovel the sand from the cars to the bin. At other points we elevate the sand into the bin by means of compressed air. Blue prints of bins, air pipes and tubes also enclosed. We use the ordinary wire screen. At some points on our line the sand is hauled by teams and delivered at the dryer. At other points it is delivered in car-load lots, and unloaded with shovels. We have no conveyor in use. Our air compressors are run by steam power. The average cost of sand delivered in our dry sand bin is about 55 cents per cubic yard."

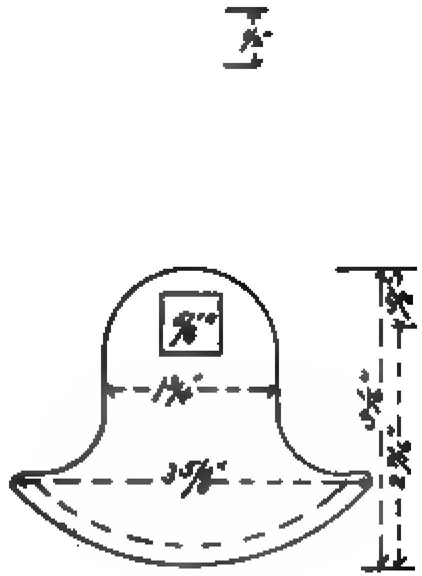
SAND DRYING PLANT M., K. & T. RY., OF TEXAS, DENISON, TEXAS.

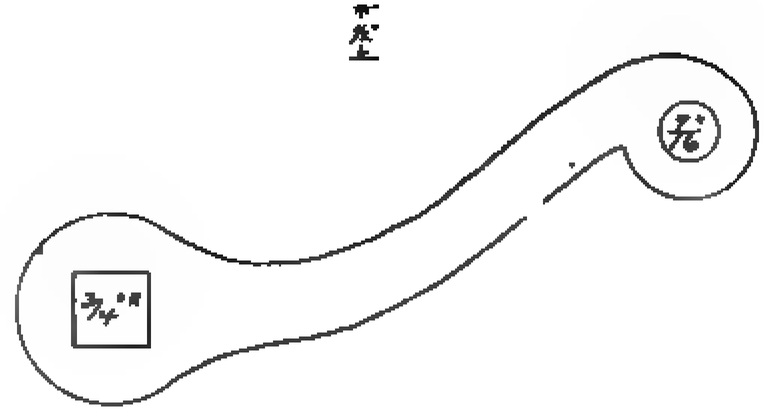
Mr. C. T. McElvaney, M. M. of this road, kindly furnished the following information:

By means of this plant one man working ten hours per day is enabled to dry and store ready for use 500 cubic yards of sand per month. The plant has been in use for three years, and has cost practically nothing for repairs. The building consists of a sand shed 68 feet long, 19 feet 6 inches wide, 11 feet 5 inches high to the eaves, having at one end a drying house 12 feet by 19 feet 6 inches, and 27 feet 8 inches high to the eaves. Fig. 1 shows a plan of the drying house and a portion of the sand shed. Fig. 2 is a transverse section through the drying house. A small engine is located in one corner, and operates the conveyor and elevator. A steam dryer 17 feet 6 inches long is placed in the shed adjacent to the house, and both the dryer and engines take steam from a boiler plant located about 400 feet away. The sand to be dried is shovelled into the dryer (A), where the steam-heating coils soon take the moisture out of it. As it dries it falls through a trough at the bottom of the dryer, from whence it is carried to the conveyor (B) into the boot (C) of the chain elevator (D). From thence the sand is conveyed up to the small iron tank, from which it is allowed to flow through a spout (E) into the revolving screen (F). This screen is 42 inches long, 10 inches in diameter at the small end and 27 inches in diameter at the large end, and is composed of netting having 4 meshes per inch and made of wire No. 12, A. W. G. The fine sand passes through the screen and falls into the tank (G), while the coarse material goes through a spout (L) to the outside of the building. From the tank (G) the screened sand is carried by the elevator (I) to the top of the building, where it is discharged through the spout (J) into the storage bin (KK). These bins have spouts somewhat similar to those of an ordinary water tank, and swing into position so as to deliver the sand into the locomotive sand box. The fireman, by means of a lever, operates the valve of an air cylinder, by which the sand valve is controlled. An accidental waste of sand is prevented by so arranging the mechanism that the valves have to be held open and as soon as the operator lets go they close automatically. In Fig. 3 we show a view of the air cylinder and controlling valve employed to operate the sand valve. The latter are slide valves, and travel over a hard wood seat secured to the inside of the bins (KK). The valve is quite large and has a port 4 inches in diameter. The size of the valve and the possibility of having considerable pressure on it when the bins are full, make the air cylinder a great convenience. Our drawing shows only the fixed portion of the sand spout. A study of the drawing shows that the plant has been constructed in a substantial manner, and that all hand labor has been avoided except that of shovelling the sand into the dryer. The building is placed with one side of it to the main



Sand plant at Dennison, Texas. (Courtesy of Railway Engineering and Mechanics.)





Full Size details
Sand Valve

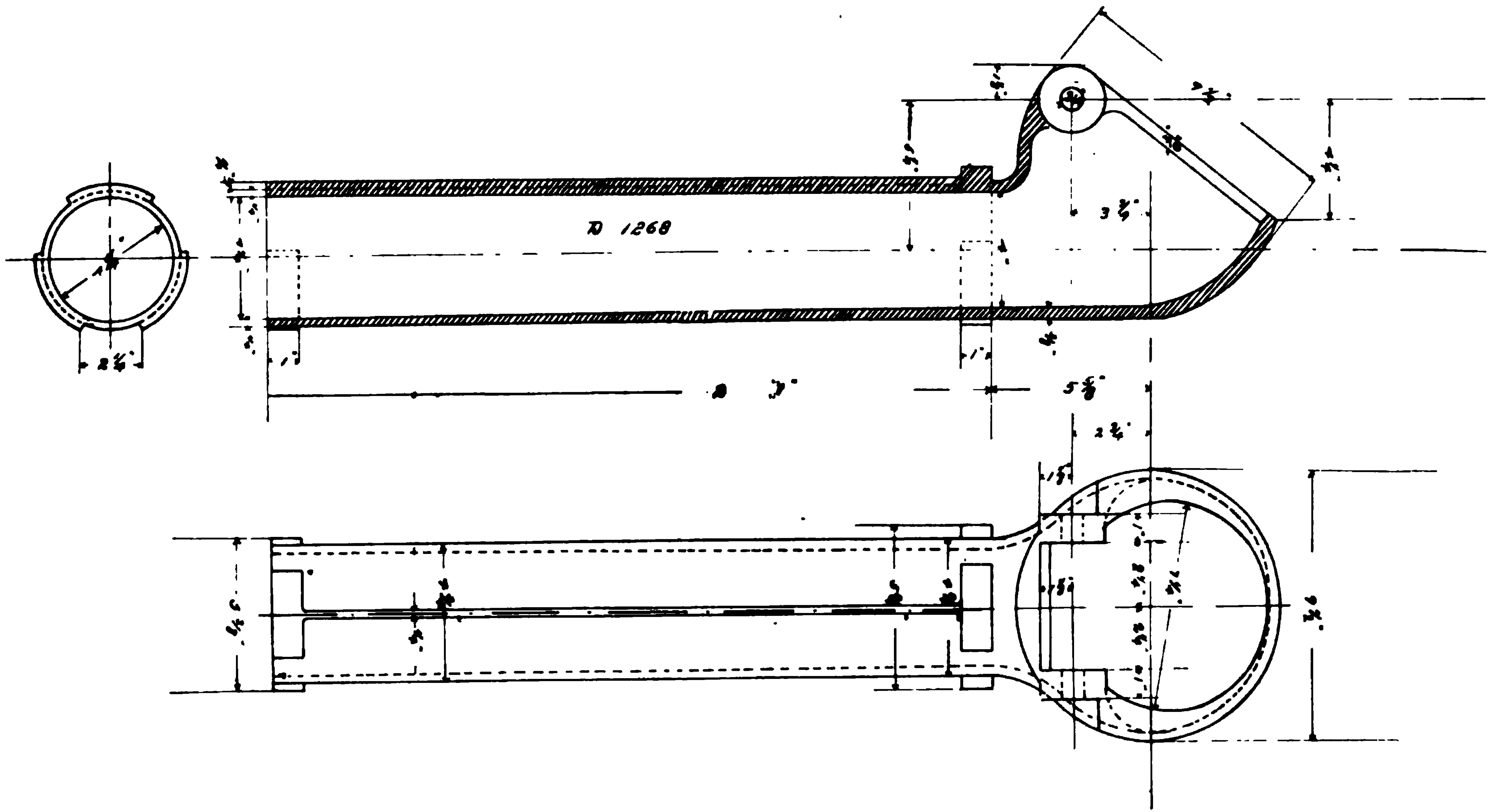
M., K. & T. Railway

track and the other the round-house track, and engines can receive sand from either side. Before the erection of this plant four large sand stoves were kept going night and day to supply the demand, and the cost of drying the sand and delivering it to the engines was much greater by the old method. In this connection, beg to say that one man at a dollar and a half per day attends to the entire operation of the plant and unloads the sand used from cars into the sand house. We dry sand for an average of forty engines every twenty-four hours, which is about 75 per cent. of its capacity. Cost of sand house would be about $1,200. We convey steam about 400 feet through a 1¼-inch pipe. Should one desire to put in the dryer without the elevator, a small upright boiler 30x60 would furnish an abundance of steam and be far more economical than sand stoves. Four to five tons of coal per month dries all the sand we use.

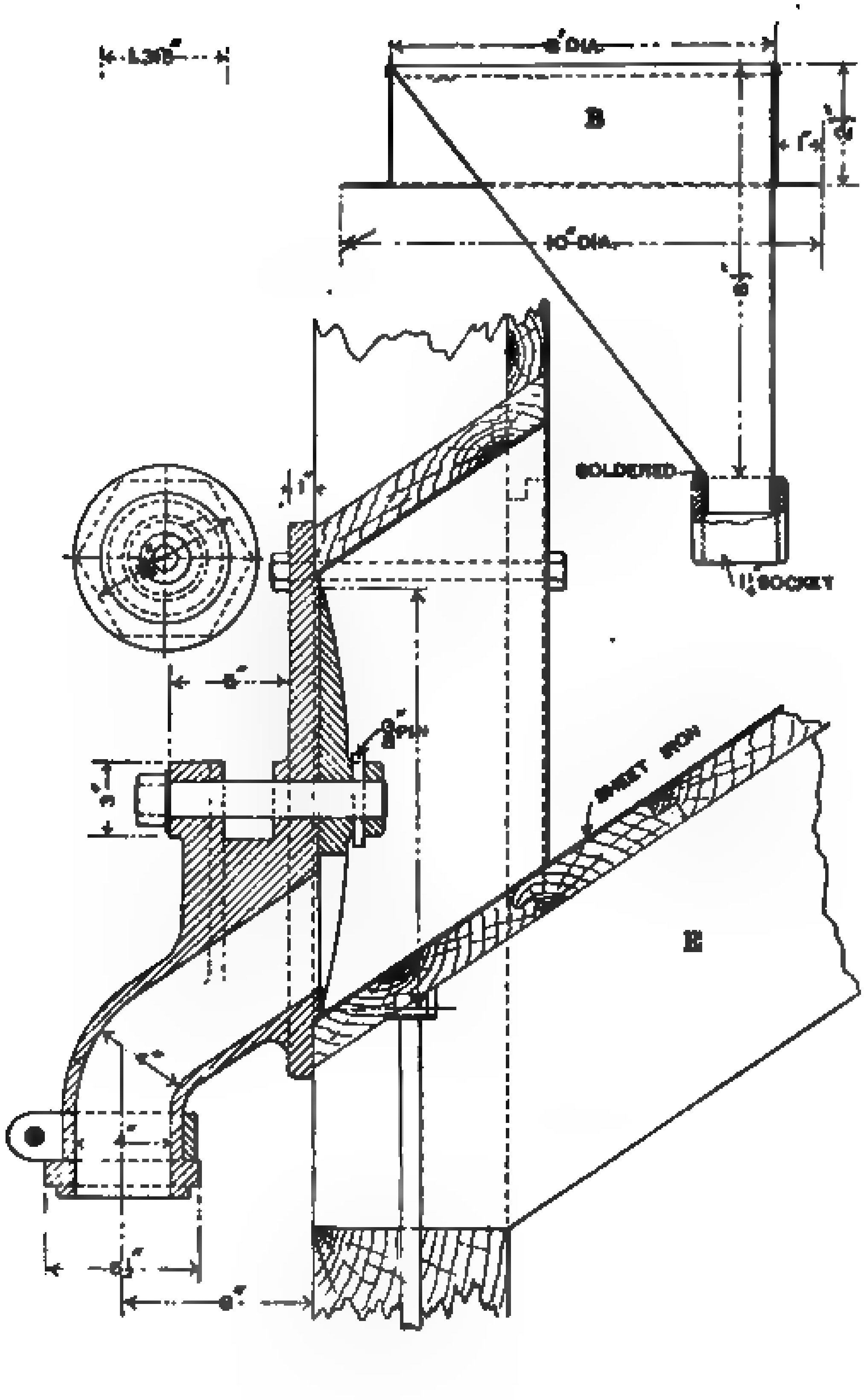
The three accompanying cuts for this plant were furnished the association by the *Railway Engineering and Mechanic*, of Chicago, Ill., to whom the association are indebted for the same.

SAND PLANT OF N. Y., L. E. & W., AT HORNELLSVILLE, N. Y.

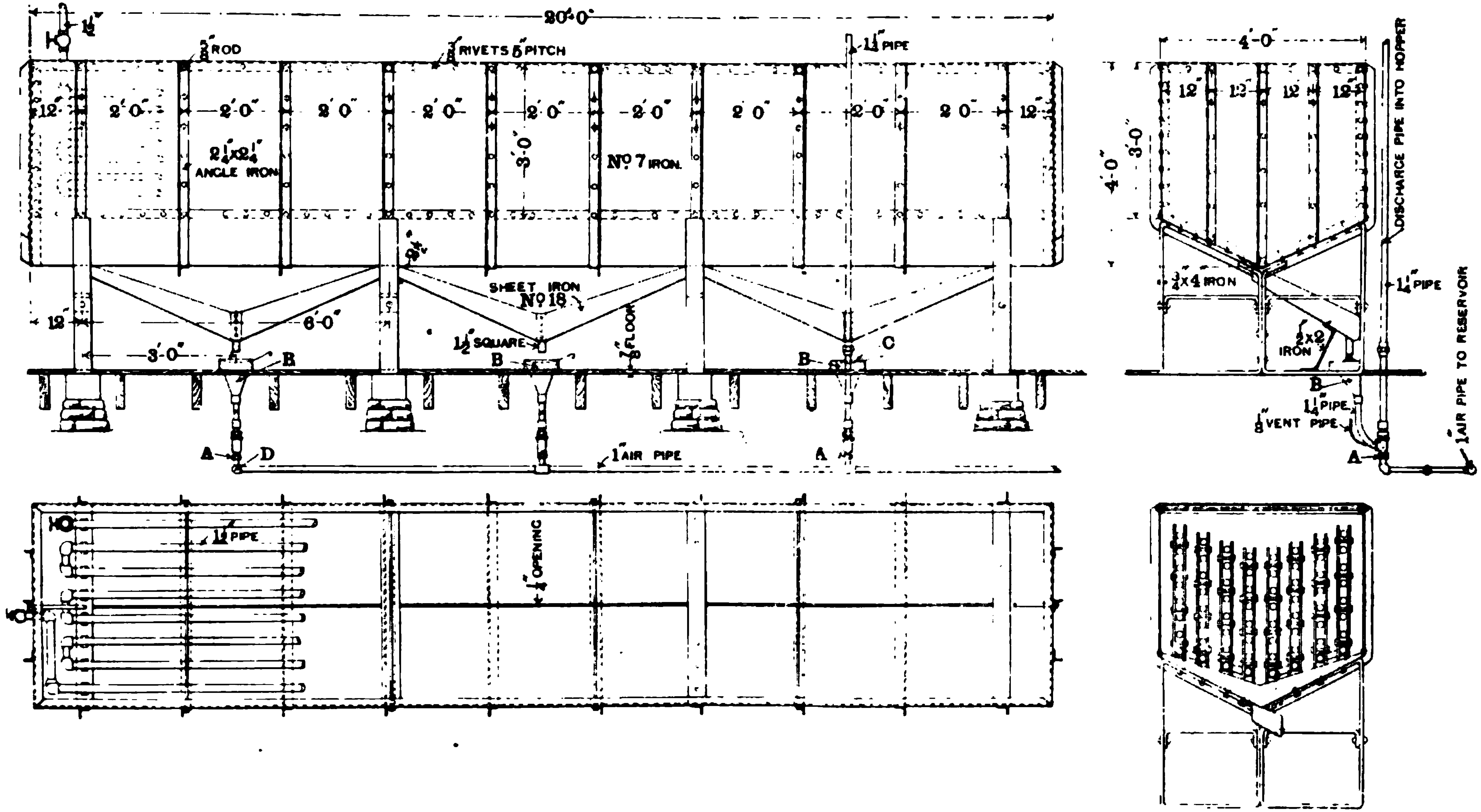
The total length of the whole building of this plant is seventy feet, forty feet being utilized for the storage of green sand, as shown in the left hand of the engraving of the elevation and plan. It consists merely of a large covered building, with doors opening between the uprights, placed at a height of six feet above the sills, and through which the sand is unloaded from the cars. The main building at the right is devoted entirely to the drying, elevating, and storage of the sand, ready for delivery to locomotives. The sand is brought in from the storage shed by means of a trolley, from which is suspended a hopper shaped bucket holding about 400 pounds of sand. This is filled, and brought to the dryer, where it is raised by means of an air hoist to an elevation above the dryer, and put upon a track running over the latter, and to which the bucket can be run to any desired point over the dryer, and dump. The dryer is so designed that no sand which is not thoroughly dried can pass out through the half-inch slot that runs along the entire length of this lowest extremity. This is accomplished by means of a convex shield that is placed directly over the lowest steam pipe, and extends out to within three-fourths of an inch of the sloping sides, where it retards the flow of the wet sand until it is dried sufficiently to run over this shield. The drying is accomplished by means of a number of rows of steam pipe that run the entire length of the drying bin, and furnishes ample heat to thoroughly dry the sand. Steam is furnished by a locomotive form of boiler, whose location is indicated by the dotted lines in the lower right hand corner, at one end of the elevation. It also provides the steam for an eight-inch Westinghouse air pump, which in turn provides the compressed air for elevating the dried sand. When the dried sand runs down through the slot, it first passes through a fine screen which is stretched over the sloping channel, and is then carried by gravity down into the mouth of a funnel, whence it passes directly into a blast pipe, and is blown by the current of air coming from the air pump into the storage bins above. In order that the amount of sand elevated may be regulated in proportion to that required, the portion below the bins is divided by two sections, each having its own independent hopper and pipe. This also enables one of the pipes to be shut down, for repairs, without stopping the whole plant, or disturbing either of the others. When this is done, the air pressure is increased in the two remaining sections, and nearly as much



Sand Plant on N. Y., L. E. & W. R. R.



Sand drying plant at Hornellsville, N. Y. (Courtesy of American Engineer and Railroad Journal.)



Sand drying plant at Hornellsville, N. Y. (Courtesy of American Engineer & Railroad Journal.)

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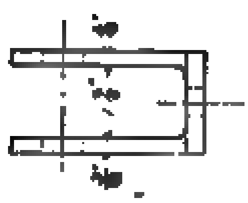

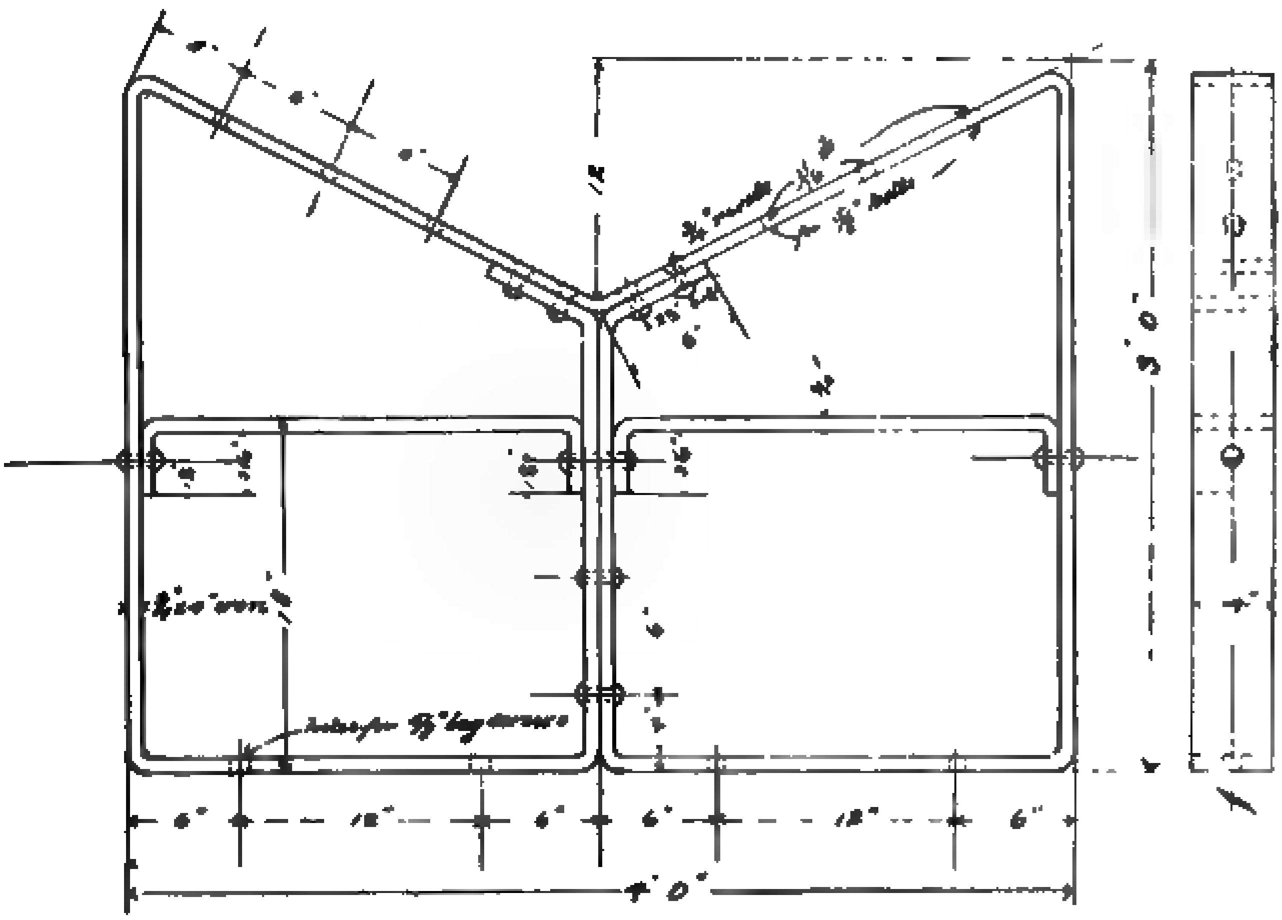

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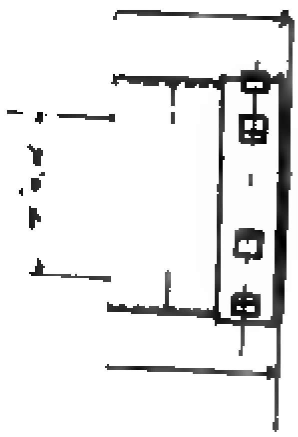
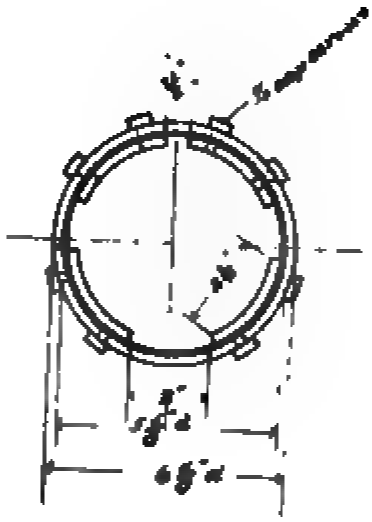
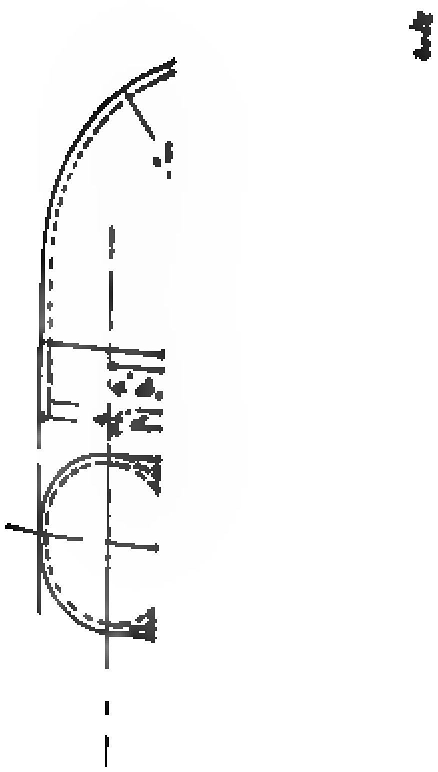
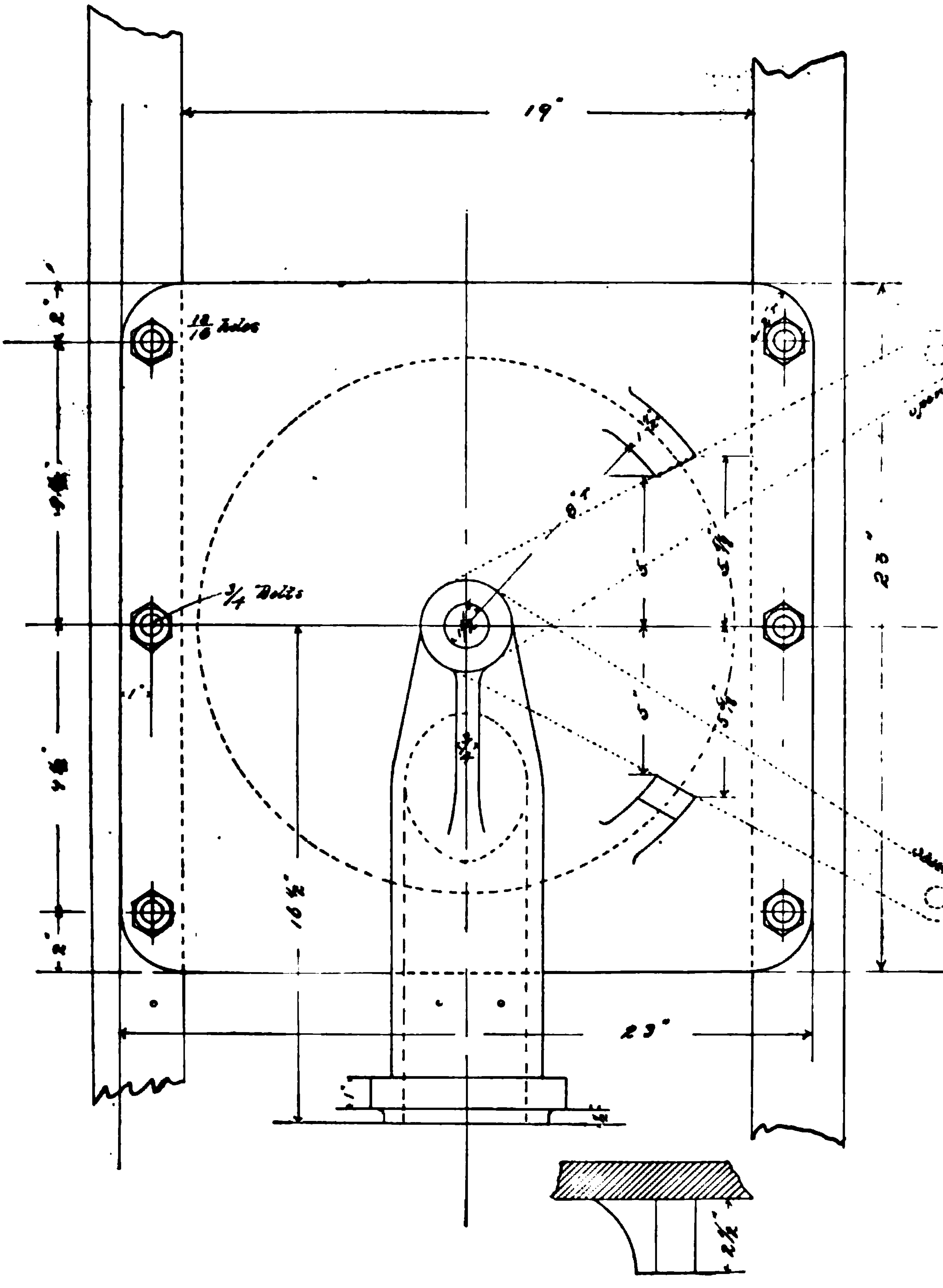
Sand Plant on N. Y., L. E. & W. R. R.

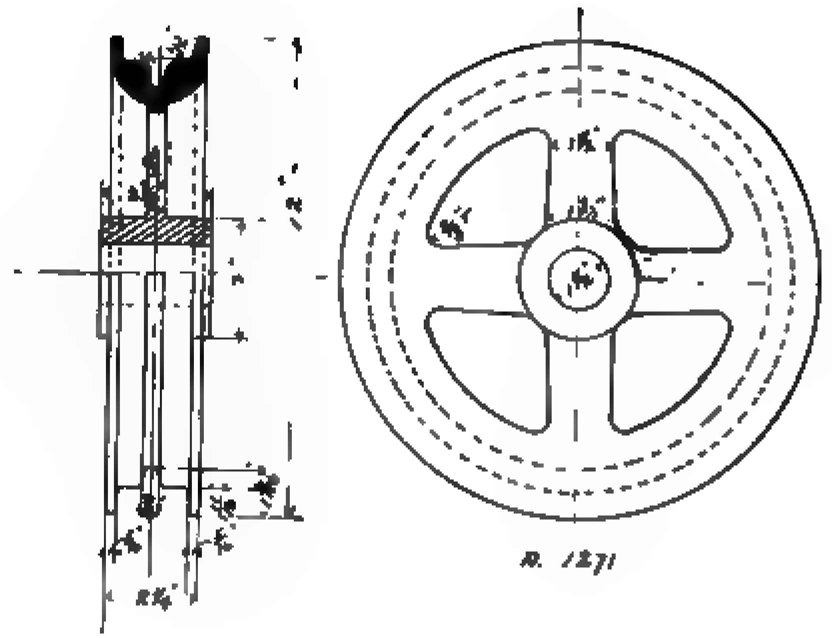








Sand Plant on N. Y., L. E. & W. R. R.



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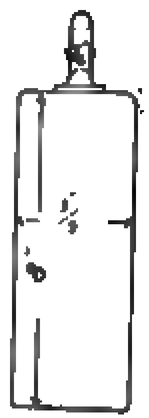


R 1270

Sand Plant on N. Y., L. E. & W. R. R.

R 5329

work is done with the two at such times as with the three when working under the normal pressure of twenty-five pounds per square inch, showing that the actual capacity of the plant is considerably above that at which it is rated, which is an average of fourteen tons of sand per day dried, and elevated to the storage bins, or enough to supply from sixty to seventy locomotives. The storage bin, into which the dry sand is elevated, is of sufficient height so it will flow into the sand box of the locomotive by gravity. The upper elevation of the building shows the line of rails running alongside the building, with the height of the top of the sand boxes of several of the classes of locomotives which are in use upon the road, a spout like that ordinarily used for water enables the fireman to take on sand in exactly the same way that he usually takes water. Referring to the details of the sand bins, as shown in Figures 1 and 2, they will require but a brief explanation. In Figure 1 is a side and end elevation, with a plan and cross section of a three-fold dryer. The dryer is twenty feet long, and occupies half the length of the drying portion of the building. The sand, after being throughly dried by the heat of the steam pipes as already described, drops through the slot in the bottom, and running down the incline, flows into the funnel (B) through the strainer netting (C). This latter is made of wire with six meshes to the inch, and is readily taken out for cleaning. The funnel (B) is made of galvanized iron, and is of the dimensions given in Figure 2. The action of the air blast will be easily understood by referring to the end elevation in Figure 1. The sand flows out of the bottom of the funnel (B) and through the curved pipe into a "T" in the bottom of which the air nozzle (A) is screwed, here it meets the air blast, and is carried up the one and one-fourth inch discharge pipe to the hopper above. The section (E), in Figure 2, is drawn through the outlet from the storage bin. The section shows the disc valve open for the flow of sand, but a pull upon the lever attached to the stem of the same in the opening shown in the casting on the outside of the building, will give the valve a quarter turn, and shut off the flow of sand. All working parts are readily accessible for repairs, and their dimensions are fully given on the engraving.

Cuts for the plant above described were kindly furnished the committee for the association by the *American Engineer and Railroad Journal*, M. N. Forney, publisher, 47 Cedar Street, New York, for which the thanks of the committee are extended.

A plant similar to the above referred to is located at Huntington, Ind., on the Chicago & Erie R. R., excepting the sand is dried by stoves instead of steam.

The following report is from W. O. Eggleston, master carpenter of C. & E. R. R.:

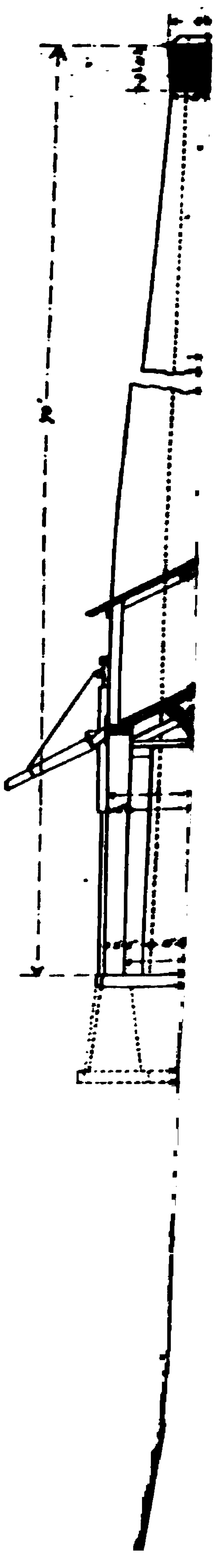
"The sand is unloaded from the cars to storage bin by hand, at a cost of a dollar and twenty-five cents per car. It is then wheeled to the dryer, which is a large stove made for the purpose, with a "V" shaped hopper around it to hold the sand, which is dried by heat; as it dries it falls to the floor around dryer. It is then shovelled into the hopper with a wire screen over it, and as it falls through the screen it is elevated to the delivery bin above, ready for use. From there it is run through spout to sand box on engine as shown on print. Besides the unloading of sand from cars, there is only one man employed to operate the work, this man works twelve hours per day at twelve and one-half cents per hour. The hostler takes sand the same as they do water. Instead of the boiler being located in the sand house, as shown on print, it is in the round-house, and furnishes power for some small machinery used there. This boiler furnishes steam also to elevate the sand, sand house being about 300 feet from the round-

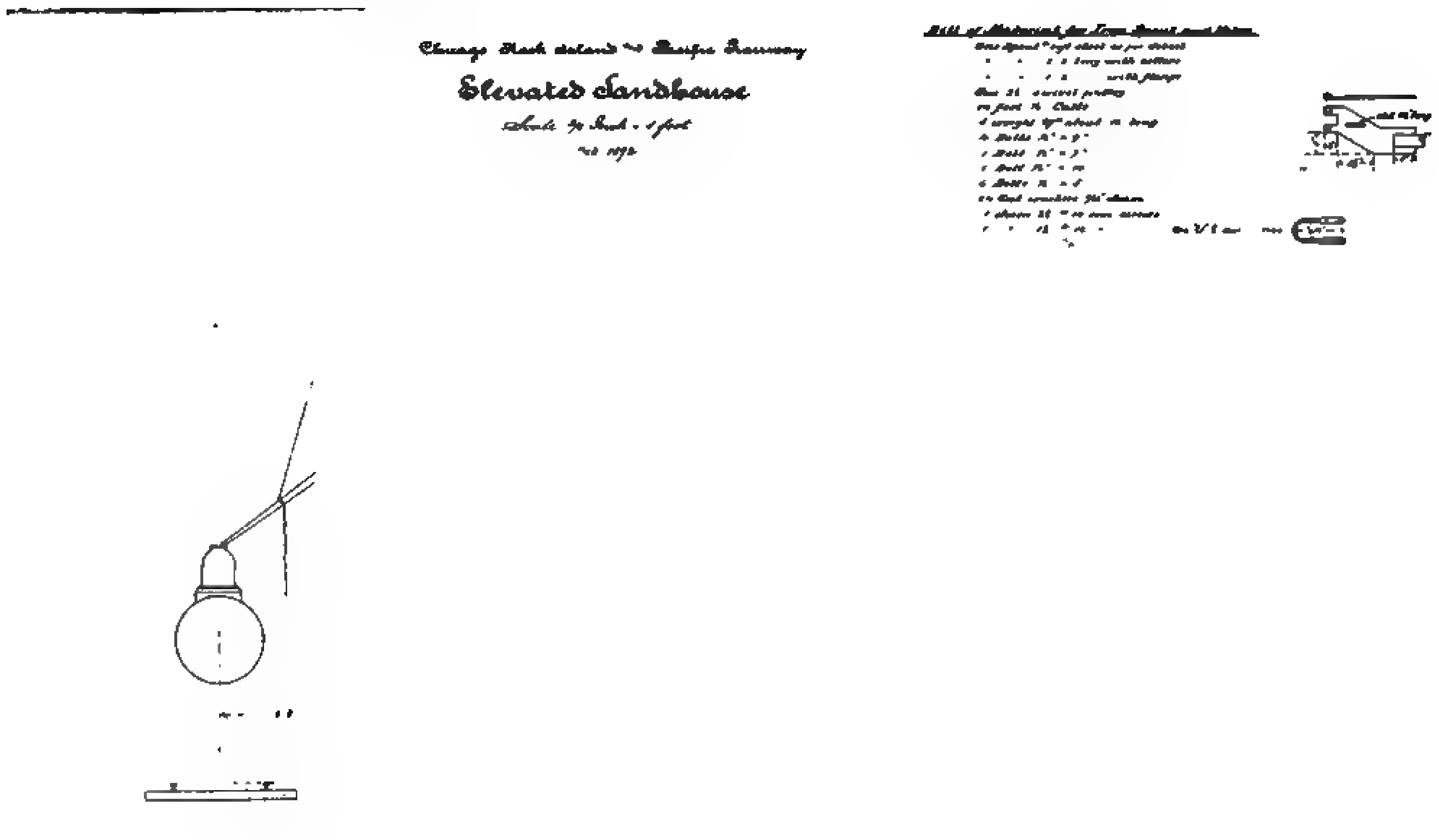
house, through two eight-inch air pumps and a thirty-inch reservoir, this air passes through a two-inch pipe to the elevator, where it reduces to one-eighth of an inch just at the mouth of pipe to receiving bin, and is a success in all respects, as you see the cost of all labor is nominal, the man that dries the sand furnishes it for about seventy engines in twenty-four hours. Add to it the cost of the proportion of furnishing the power to elevate the sand and unloading it from the cars, places the cost of sand at about three cents per engine. The first cost of outfit was $1,600. Hoping this will be satisfactory."

SAND PLANT C., M. & ST. P. RAILROAD, LOCATED AT WEST MILWAUKEE, WIS.

Building of brick with iron trusses and slate roof—ninety feet long, twenty feet wide, in which all machinery, etc., is contained for drying and storing green and dry sand. The former in space twenty-eight and one-half by twenty-nine feet, the latter in center twenty-nine feet by seven feet four inches, which is elevated to a height sufficient for elevators to convey dry sand to bins for that purpose by link belting and buckets. Fifty-eight feet by twenty-nine feet is used for machinery for drying sand, pump room, and coal bin for engine, and pump; sand hopper, six feet wide, six feet, ten inches long, attached to front end of locomotive boiler, which also furnishes steam for sand elevator engine and other purposes, through which steam coils are run. This together with the heat from the boiler dries the sand. And as sand is dried it is conveyed by gravity to boot of elevator, from where it is elevated to a dry sand bin, of which there are two at some places, one on each side of the building, so sand can be taken on either side at the same time, or built single, if so desired. The elevator being run by steam or hand power, in connection with the drying of sand, is also a pump by which water is pumped for locomotives, all of which can be accomplished by the same man who attends to the drying of the sand. Orland Bates, engineer and superintendent of B. & B., of C. M. & St. P. R. R., reports as follows:

"Replying to your circular letter of April 20th, 1895, asking, in behalf of the American International Association of Railway Superintendents of Bridges and Buildings, for information concerning various methods of drying sand for locomotive use, our practice is limited to two systems,—the coal stove with sand hopper attachments and the steam dryer described below. The first system is one which we employ at intermediate stations and at certain division points. The wet sand is stored in bins out of doors or is unloaded directly into the sand house, which is usually a small frame building. The wet sand is handled with shovels and wheelbarrows and the dry sand is handled with shovels and buckets. The drying arrrangement is simply a hopper attached to an ordinary cast-iron, soft-coal stove and the sand is dried by the means of the heat radiated from the upper part of the fire-pot and from the section of cast-iron stove-pipe between the top of the stove and the top of the hopper. As the sand becomes sufficiently dry it passes through the apertures in the base of the hopper and is screened into bins through screens usually made of locomotive stack netting. Sand sent to the sand-house in cars is unloaded by shovelling. The cost of operating this dryer is dependent upon the amount of sand used, and whether the men operating the dryer have other business to attend to. There is only one station on this company's line where the amount of sand used is sufficient to require the constant attention of the man operating the dryer and at that station it is estimated that the cost is about eight cents for





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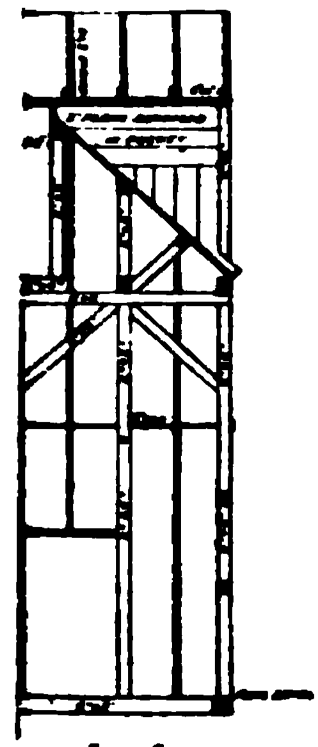
Sand Plant, C., R. I. & P. R. R.



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each locomotive. Our standard steam system of drying is employed at division points where we have constructed a combined boiler and sand-house in connection with the round-house and other buildings incident to a division station. It consists of a hopper attached to the front end of a stationary boiler. The wet sand is stored sometimes outside the sand-house, either exposed or under sheds, and sometimes in the round-house proper. It is usually supplied to the hopper by wheelbarrows, but in one instance we have the wet sand unloaded into the bin, from which it is conveyed to the dryer by steam power. The operation of drying is by means of steam coils in the hopper mentioned and in addition to whatever heat may be radiated from the boiler itself. After being dried the sand is screened into a pit below the dryer, and is elevated to a sand-bin in the upper part of the building, from which it is conveyed to the locomotive through a spout on the outside of the building operated in very much the same way as a water tank. The power used to elevate the dry sand into the bins is sometimes steam and sometimes hand. The latter is not very satisfactory. Under this system the sand is always unloaded by hand, but when the sand house is built, adjoining the elevated track of the coal chute, we have arranged to unload the cars from the elevated track. There are certain modifications of the above two systems which are immaterial. One of which is in operation at certain stations to supply the sand to locomotives by means of a crane and bucket, the latter having an outlet and valve in the bottom. This is considered more economical than using buckets where there are many engines requiring the sand, and in the line of equipment it may be said to stand as an intermediate between a stove equipment with buckets to handle the dry sand and the boiler equipment with an elevator and elevated bins. I send you, under separate cover, copies of such drawings as we have, which will be of assistance to you in this report."

SAND PLANT DULUTH & IRON RANGE RAILROAD, LOCATED AT TWO HARBORS, MINN.

Mr. W. A. McGonagle, Supt. B. & B., reports as follows, which fully explains its operation:

"I enclose plan of our present sand-house and dryer. This system is operated by receiving the sand on flat cars, shovelling same into the bins on ground floor, screening the sand and allowing it to run into the dryer, which in this case is a sheet-iron hopper with stove inside, and then elevating the dry sand to high bins above by crane and bucket operated by hand. The sand is thence conveyed by a spout to the dome on engine, and it requires but a moment or two to take a supply of sand. The plant is operated by one man by day and another one at night, the wages in each case being $1.50 per day. The building is covered outside with corrugated iron, and the master mechanic reports that it operates successfully. I am now preparing plans for a new and much larger plant, in which the sand will be dumped from a hopper-bottom car into a pocket, and will run over screens into a screen dryer and from thence be elevated by an air blast to the pocket above. This will eliminate all labor of shovelling, and the cost of operation, on account of the limited amount of compressed air used, will be very much less than at present."

SAND PLANT CHICAGO, ROCK ISLAND & PACIFIC RAILROAD.

Built adjoining an elevated coal-dump track, on which sand in cars is run to an elevation sufficient for engines to take sand in same man-

ner water is taken; sand dried by a common stove for that purpose. Building for sand-house purposes, 9 feet wide 33 feet long, elevated, with floor of same 4 feet above top of rail on elevated track. Dry sand hopper, with flat bottom, located at one end, drying room in centre, green sand in opposite end. With this arrangement the necessity of elevating sand by machinery is dispensed with, making it very cheaply constructed and economical for handling sand at small stations or terminals. Spouts through which sand is supplied to engines are of telescope pattern, hung on weights, admitting of sand being given to engines of various heights. Mr. George J. Bishop, general foreman B. & B., reports as follows:

"We have a large sand dryer, built like a stove, with a sheet-iron funnel fastened to dryer, that will hold about one and one half yards of sand. The sand is dried in the heat of the fire. The engines are filled by buckets, and also by telescope drop-pipe, from the elevated sand-house, built on coal-chute incline. The elevated sand-house is made to hold about three cars of green sand. The sand dryer is filled by hand, with a scoop shovel. The dry sand is shovelled into a bin built for that purpose, made to hold a car of dry sand, for filling engines. The drying apparatuses are very crude affairs, and cost $39.50 each. They will dry an average of about 40 bushels of sand per day with one stove. The cost of labor, $1.25 per day. The sand boxes on our engines hold about 7 bushels of sand each. It is hard to determine the exact cost per engine, as the man who does the sanding is not working at it continually; in fact, I do not think he devotes more than one third of his time to it,—filling up the hopper and sifting the dry sand, and the balance of his time we utilize for other purposes. I think that one cent per bushel, or seven cents per engine, will be a liberal estimate."

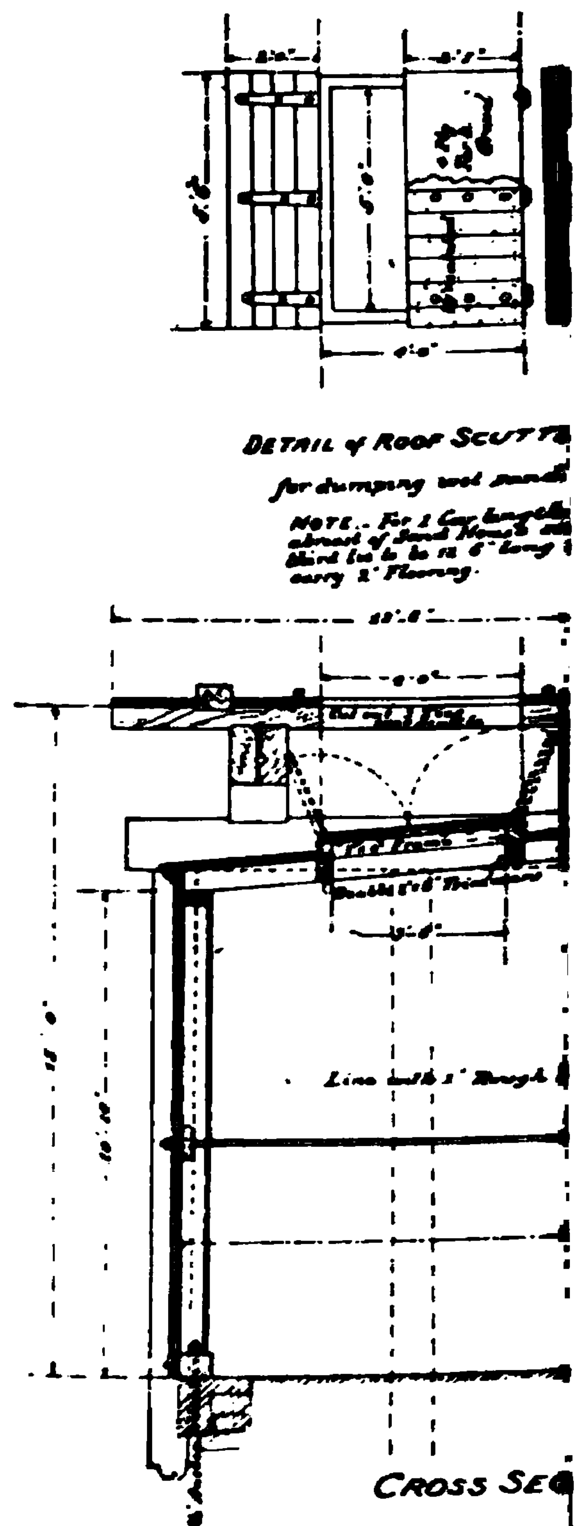
SAND PLANT C., C., C. & ST. L. R. R., BELLEFONTAINE, OHIO.

Green-sand bin fifteen by twenty-one feet, half of which extends under elevated coal-dump track. By this arrangement sand can be unloaded from drop bottom cars through door in roof of house for that purpose, or shovelled from cars standing on main track. Capacity seventy-five yards, stoves, sand drying, and elevator room nine feet ten inches wide, eighteen feet long, thirty-one feet high. All built of wood, with four-ply gravel roof and adjoining coaling-station. Elevator of link belting operated by hand. Has dry-sand hopper where sand is elevated and taken by engines the same as water. Mr. A. Shane, superintendent of B. & B., reports as follows:

"I hand herewith blue print of standard sand-dryer and elevator. Cost of building, $250. Sand elevator, $62. Dryer, $10. Concrete floor, $27.50; total, $349.50. Storage capacity, seventy-five yards. Drying capacity, twenty yards per day at a cost of six cents per yard."

SAND PLANT ST. LOUIS & SOUTHEASTERN, TEXARKANA, TEXAS.

Building of frame twenty by thirty feet. Green-sand bin ten by thirty, two dry-sand bins eleven by ten feet each, between which are located drying stoves. The building elevated to sufficient height that green sand is shovelled from cars into bin on level with dry-sand bin. Floor of dry-sand bin on level with running board of engine, extending three feet outside of building and next to engine, to which apron with hinge attachment is secured used to walk on while sanding engines. Outlet spout of hopper elevated sufficient height above platform for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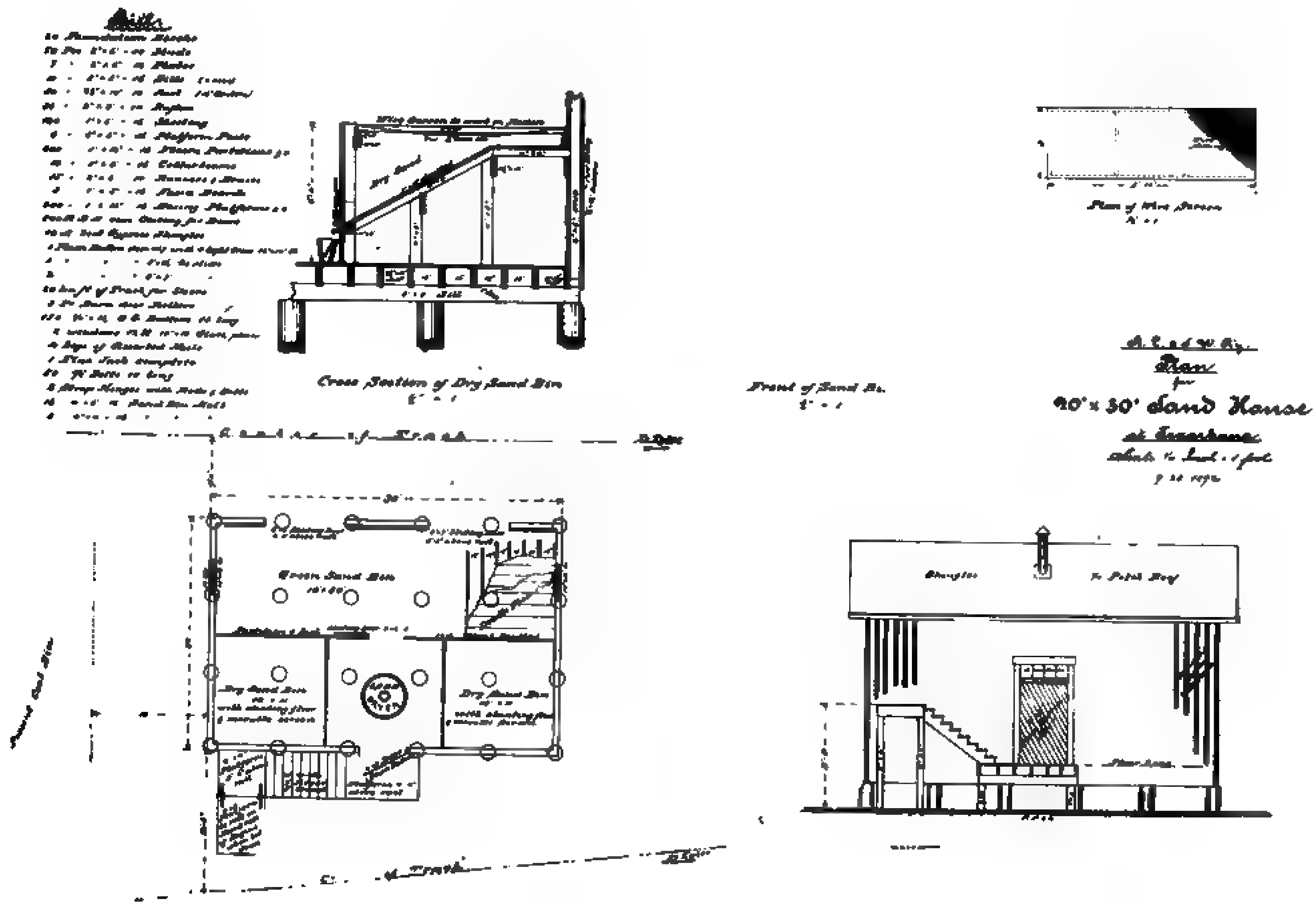
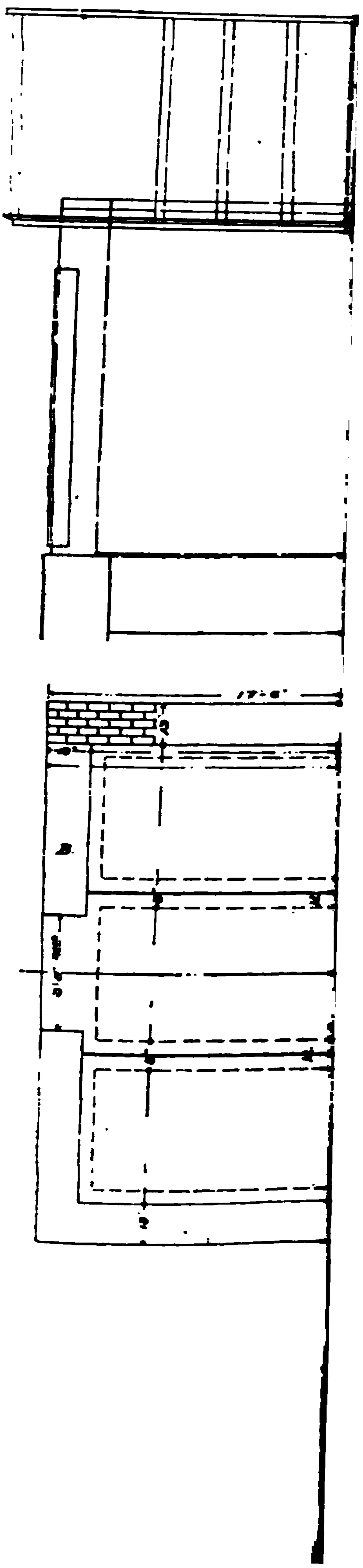
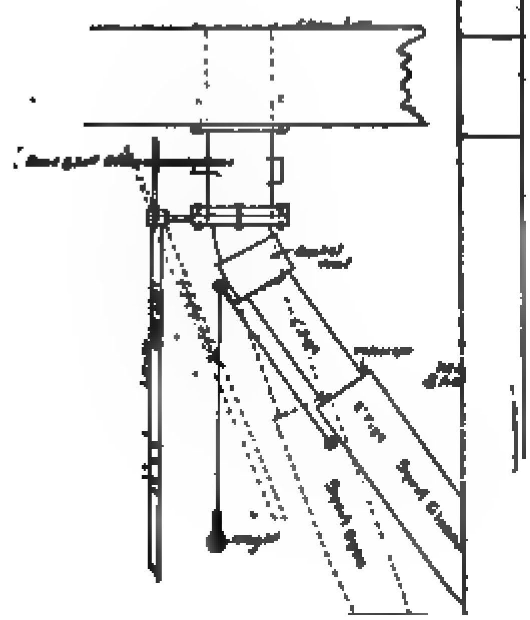


Sand Plant, St L. & S. W R R., Texarkana, Tex.



SAND SPOUT.



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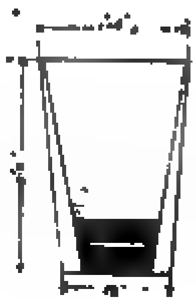

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SA

ARRANGEME

sand bucket to stand under while being filled from sand bin by gravity. With this arrangement one man can sand engines very easily, which is a labor-saving device. J. S. Berry, assistant superintendent B. & B., reports as follows: "Replying to your favor of July 22d, I will say that I am not prepared to give you the information I would like on the subject. I am figuring on a sand-house dryer and elevator, by which the sand is to be dried by steam and elevated into the hopper by compressed air, with slide and spout attachment for delivering the sand into the sand box of the engine. I have not the plan far enough along to give you an idea of what it will be, but if I get them completed by the time your report will be ready, I will send you a blue print. Under separate cover I mail you to-day a blue print of our present sand house and dryer, as good as any I have seen in this country. All the work, of course, is done by hand. You will notice outside stairway where sand is taken up by a bucket, and at the top of landing a door which is lowered down on to the running board of the engine, the sand carried across and put in the sand box of the engine."

SAND PLANT LEHIGH VALLEY RAILROAD, SAYRE, PA.

Sand drier is located over entrance to the round-house. Green sand, after being screened, is elevated to the steam drier by link belting elevator operated by steam. Steampipe is used, consisting of three sections of twenty-five double lines of one inch gaspipe, with double manifold connections at each end, and quarter turn at the angle. The horizontal section eight feet long, vertical section two and one-half feet long. Underneath the horizontal sections gravel grate is located. Sand, after being dried, passes through this grate to dry-sand slide, which is inclined sufficient for dry sand to pass off readily to dry-sand hopper, from where engines are supplied by a flexible pipe with valve direct to the sand box of engine.

AARON S. MARKLEY,
H. A. HANSON,
A. J. KELLEY,
J. O. THORN,
Committee.

Moved by Mr. J. L. White and seconded, that the report of the committee be received and spread upon the minutes. Carried.

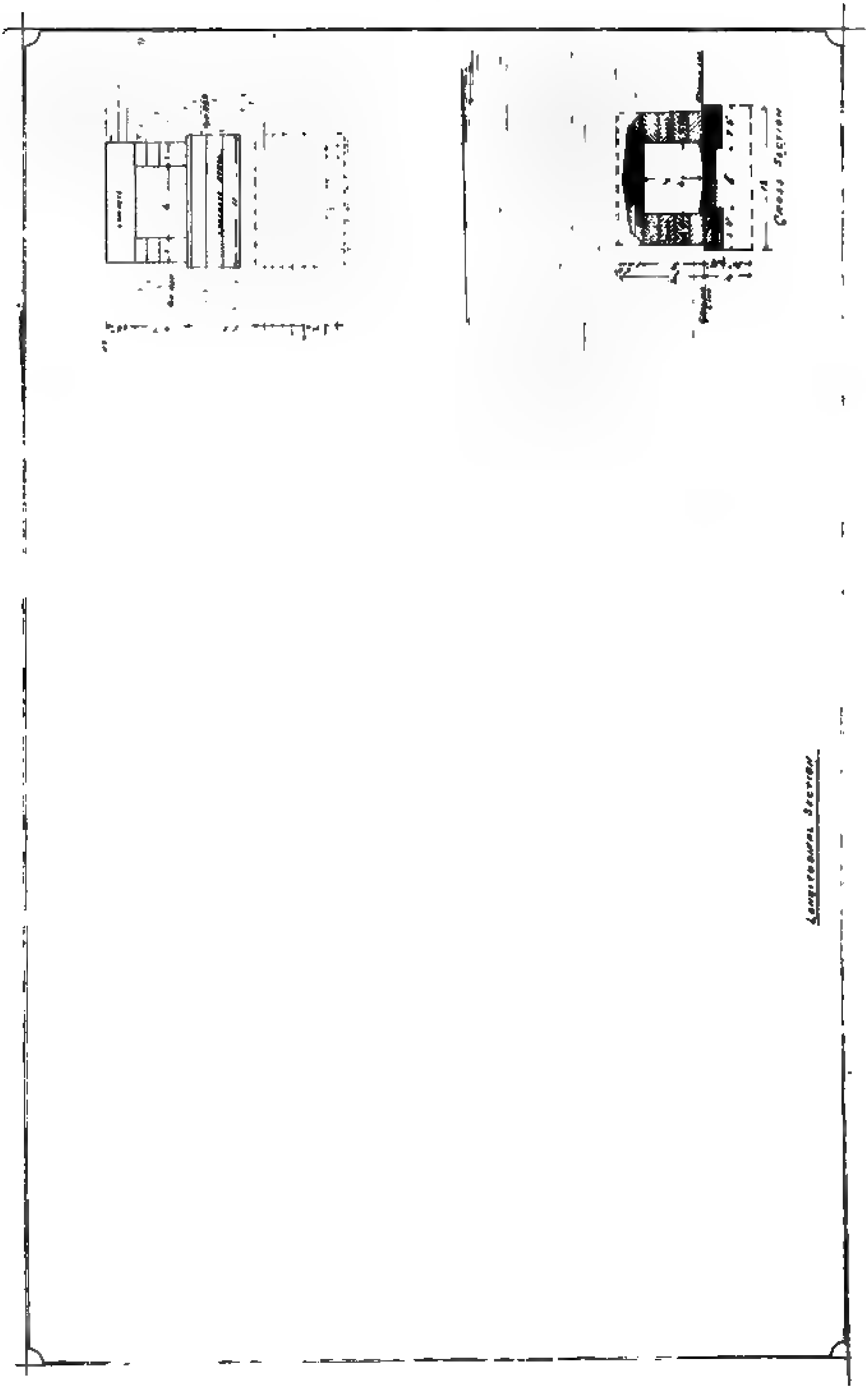
No. 8.—Best method of spanning openings too large for box culverts, and in embankments too low for arch culverts.

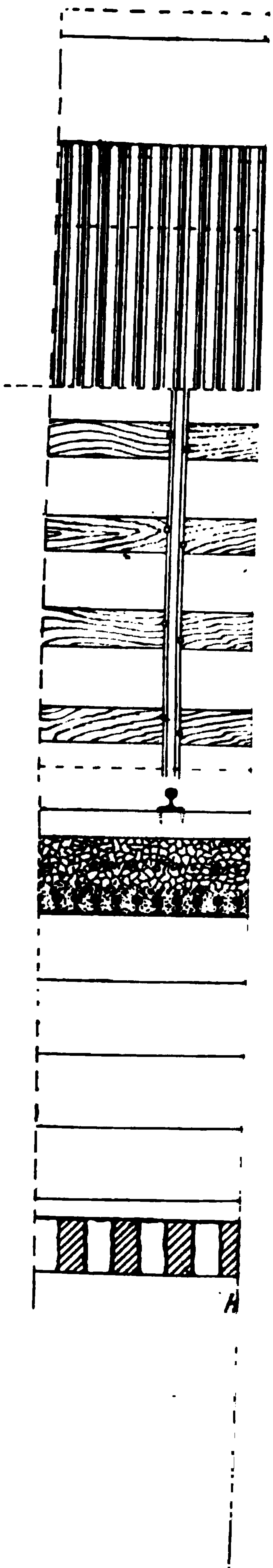
Report read by Mr. Stannard.

To the President and Members of the American International Association of Railroad Superintendents of Bridges and Buildings.

Your committee appointed at the last or fourth annual meeting held at Kansas City, Mo., October, 1894, to report on best method of spanning openings too large for box culverts, and in embankments too low for arch culverts, beg to submit the following report, which is more fully explained by accompanying blue prints.

The proper method of constructing an opening on this plan: First excavate for walls to secure a permanent and solid foundation, or where permanent foundation for wall is difficult to obtain, would recommend driving piling and put in concrete to depth of about three


Cross Section
Longitudinal Section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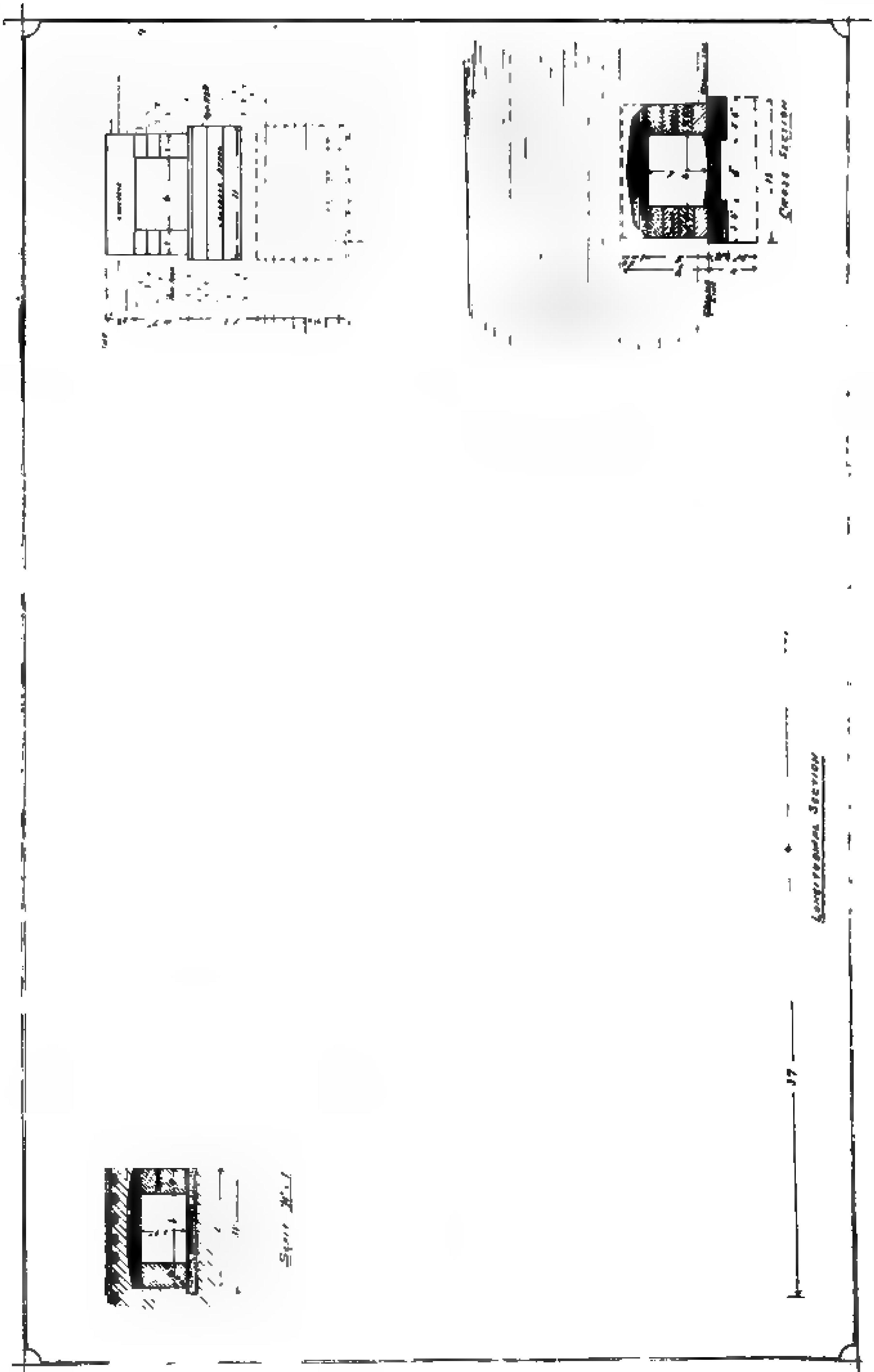
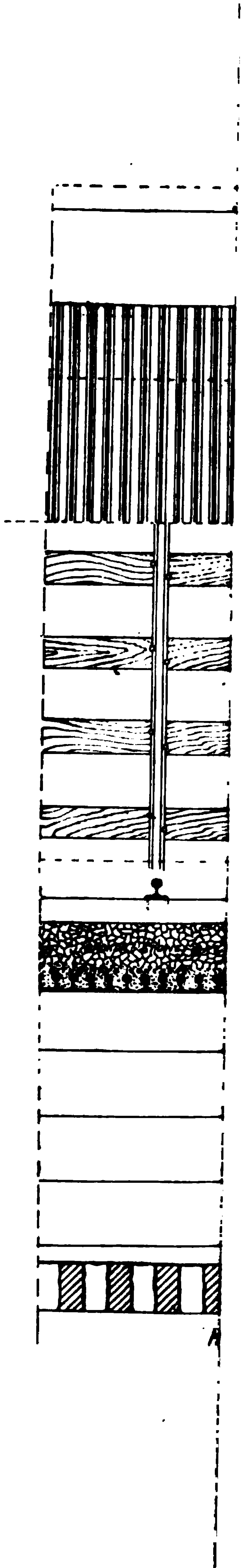

Cross Section
Longitudinal Section



feet for foundation of wall. Walls to be made of good quality rubble stone, laid in good cement mortar, composed of two parts good, clean sharp sand, and one part Louisville cement. Walls to be built to proper height, made true and level on top or last course to receive old rails which are laid close together with a rod passing through each end to hold them in place, using any kind of old track rails that have sufficient length of good rail to span the opening, and use old "I" beams or channel bar at either end of culvert to hold ballast in place. Rails and channel bar should receive a coating of coal tar to prevent rust. The retaining, or wing walls, should be built higher than main walls on which rails are placed as shown on plan, and the first piece of rock in retaining wall, above level of top of main wall, should be securely anchored or doweled to wall underneath same to resist pressure of embankment against the "I" beam. The rails should be covered with concrete to a depth of four to twelve inches, owing to length of opening. Concrete to be made highest in centre, in order to give drainage and add strength, and place about twelve to eighteen inches of ballast above concrete to bed ties in. The bottom, or water-way, of culvert should be floored with concrete to a depth of twelve inches, or paved with flat stone laid in cement mortar. Great care should be taken to extend floor or pavement on down stream side far enough to prevent wash.

This plan of culvert has been adopted and is in use on the Missouri Pacific system, also the Kansas City, Fort Scott, & Memphis Railway and other Western roads. They are used for all openings up to twelve feet in the clear. For all openings eight feet span and over "I" beams should be used under track rails to increase strength, as shown on plan.

For the class of openings referred to, this plan of culvert is considered practically the cheapest and best of anything in use.

We, your committee, deem it unnecessary to make further explanation relative to subject in question, as the accompanying blue prints show everything in detail.

(Signed) JAS. STANNARD,
L. K. SPAFFORD,
O. H. ANDREWS,
F. W. TANNER,
Committee.

Moved and seconded that the report be received and spread upon the minutes.

Mr. Cummin.—In regard to the blue prints and drawings accompanying reports, is it the intention to have copies made and printed in the proceedings? It seems to me that some of the reports of these committees will be of very little benefit to the members of the association unless this action is taken, and I think it would be well to arrange for copies.

Mr. Andrews.—The reports of any committee where blue prints or drawings are necessary to explain absolutely, require copies of such blue prints or drawings, otherwise the reports will be valueless, and the secretary will undoubtedly arrange for their printing unless action is taken to prohibit.

Mr. Andrews.—We will now take up subject No. 10, interlock-

ing signals, of which committee, J. H. Travis, chairman, is absent. Mr. R. L. Heflin is a member of that committee.

Mr. Heflin.—You remember at the time that committee was appointed,—Mr. Travis, Mr. Danes and myself,—I stated that I had no interlocking signals—had nothing to do with them, consequently knew nothing about them. On that ground you excused me, and Mr. Spangler was appointed in my stead, in consequence of which I have taken no action whatever.

Mr. A. S. Markley.—As Mr. Spangler is not present, and there is no report from the committee, I move that the time be extended.

Mr. J. L. White.—I think it would be well to amend the motion, and discharge the committee and appoint a new one. Accepted by Mr. Markley as original motion.

Mr. Cummin—I think we had better make haste slowly on that question. Is there any gentleman present who knows that there will not be any member of that committee present before this convention adjourns? If any member of that committee should happen to come in to-day or to-morrow with a report in his pocket, and find that the committee has been discharged for neglect, I think he would feel very sore; I should.

Mr. Stannard.—I think we should give them further time; and that if they do not report during the following days of the convention, they should be given another year.

Mr. Berg.—I move an amendment to Mr. White's amendment that the calling up of this subject be postponed until after all the others have been taken up.

Mr. Andrews.—The original motion is now that the report on interlocking signals be passed until the last.

Mr. Heflin.—I think you will bear me out in the statement I made relative to being excused. If from now on I am to consider myself on the committee, I will ask for another year. As far as I am concerned, I think Mr. Berg's suggestion is the best.

Mr. Andrews.—No. 10 now stands as the last.

Recess till two o'clock.

AFTERNOON SESSION, TUESDAY, OCTOBER 15, 1895.

Mr. Andrews.—No. 11, Pumps and Boilers, Mr. John H. Markley, chairman, is the next subject.

Section on Line AD

Vertical Boiler, T. P. & W. R. R.

Mr. Shane.—I would like to say the same as was said of the other committee's report this morning. I do not claim the credit or honor of writing this report; it is all due to our chairman.

Reading of report by Mr. Shane.

To the President and Members of the International Association of Superintendents of Bridges and Buildings:

Your committee appointed at the last meeting held at Kansas City, Mo., to report on "Pumps and Boilers for Water Stations," begs to make the following report:

The committee was called together by the chairman to meet at Sheldon, Ill., (the junction of the T. P. & W. and Chicago Division of the C., C., C. & St. L. Rys.) on September 10th. The following members being present: J. H. Markley of the T. P. & W. Ry and A. Shane of the C., C., C. & St. L. Ry.

THE STEAM PUMP.

This is something that is manufactured by outside firms, therefore your committee will not recommend any particular make. Either the duplex or single acting pump (with rubber packing always in water end.) The location and service the pump is to perform has all to do with the size that should be used. A new idea has lately been introduced in connecting the exhaust pipe from the pump to the suction pipe with a Y connection running towards the pump. It is done for two purposes: one to assist the suction and the other to heat the water in winter time to prevent freezing. When connected this way it is necessary to have two exhausts, one as just described and the other either in stack or out. At a point on the T. P. & W. I have a 6x4x6 duplex pump that forces the water 4,000 ft. and raises it 90 ft. through a 4 in. discharge pipe with 60 lbs. of steam pressure, and throws 3,500 gals. of water per hour.

BOILERS.

Your committee did not solicit for any great number of plans, in fact only in one case did we go outside of what the members of the committee are using and can speak from practical experience of what we have. We have plans for two boilers and submit them as a part of our report and invite the attention of every member to inspect them as no doubt they are something new to a great many. But all of them are practical and the most simple ones to construct are the cheapest and give good results. The great word of economy that we are brought face to face with nowadays causes us to enter into the simple construction of our water service boilers. The fuel that is almost universally used is coal screenings of the very finest kind, and which answers all purposes where you have boilers (such as we submit) to burn it.

1st. We have the T. P. & W. vertical boiler 36 in. diameter by 84 in. high with twenty-eight 3 in. submerged flues. It is somewhat different in construction from the average pump boiler; it has no solid mud ring or solid ring around the fire door. In this respect it is constructed just like a locomotive boiler around the door. At the bottom or water leg the inside sheet is bent out on an O G form and the two sheets are riveted together. One very important point I wish to call the members' attention to and that is to keep the grates up plenty high enough so the fire will not heat the boiler below the water line. This boiler

cost $175.00 complete. There are many who still cling to the old idea that the pump boiler must have as many 2 in. flues as you can possibly get in. If any of the members of this Association have that idea all they have to do is to build a boiler such as this committee recommends and they will have no other in the future.

2d. We have the C. & E. I. vertical boiler. The plan is for a 48 in. x 10 ft. They also make a 36 in. of the same plan. The 36 in. cost $130.00 trimming and base, complete $159.00. The 48 in. cost $206.00 trimming and base, complete $235.00 This pattern of boiler has been in use 14 years. One boiler ran 11 years without removing; it was then taken out to have a patch put on around mud ring. The fuel used is soft coal and they are good steamers, raise steam in 45 minutes from cold water. Dimensions of material top head, crown sheet, and fire-box 3-8 in., balance 5-16 in. Your committee has canvassed the boiler subject pretty thoroughly and agree on recommending either of the two plans submitted; and a cut of them to be inserted in the proceedings of our fifth annual meeting.

(Signed) J. H. MARKLEY,
Supt. B. & B. T. P. & W. Ry.

(Signed) O. J. TRAVIS,
Supt. B. & B. E. J. & E. Ry.

(Signed) A. SHANE,
Supt. B. & B., C. C. C. & St. L. Ry.

(Signed) G. W. MARKLEY,
Supt. B. & B., C. C. C. & St. L. Ry.

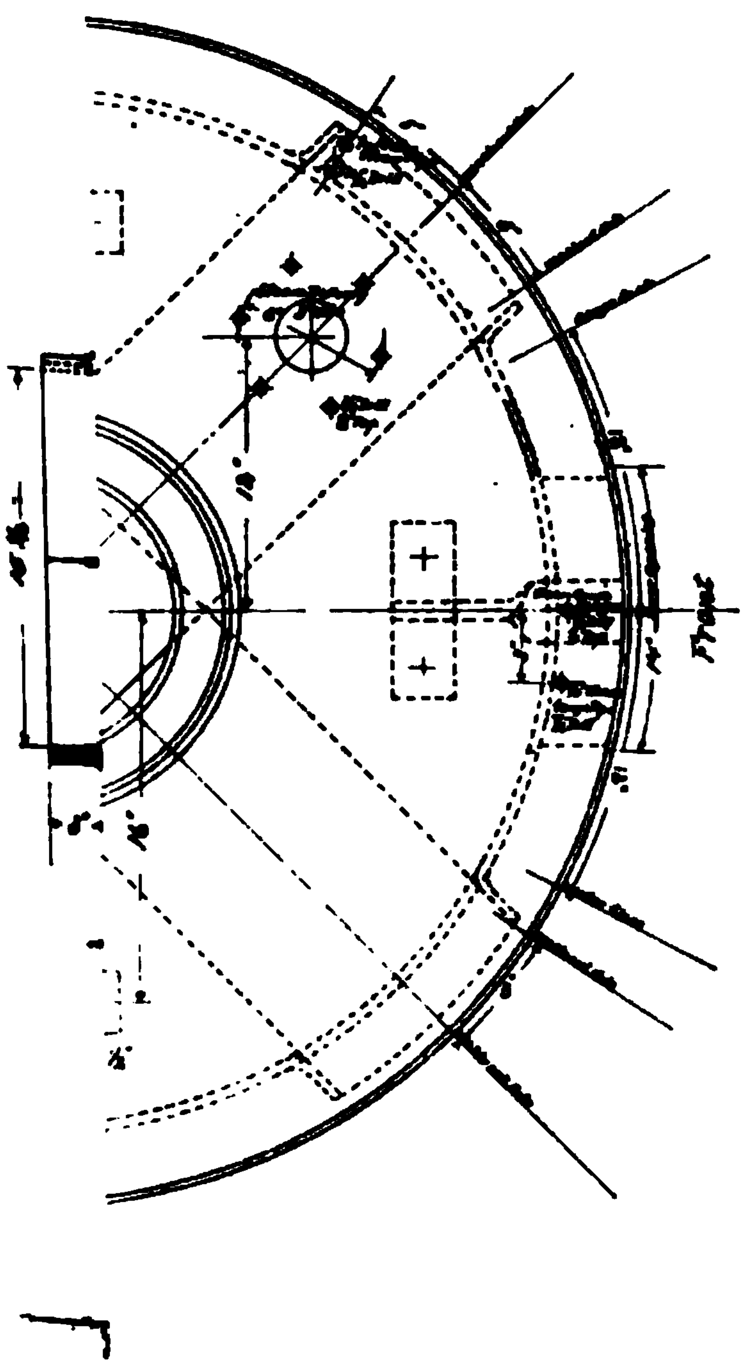
Mr. Andrews.—We will now revert to subject No. 2—"Methods and Special Appliances for Building Temporary Trestles over Wash-outs and Burn-outs."

Mr. Cummin.—Mr. Peck has requested me to read his report, and with your permission I will do so.

METHODS AND SPECIAL APPLIANCES FOR BUILDING TEMPORARY TRESTLES OVER WASHOUTS AND BURNOUTS.

When a washout or burnout occurs, the first information necessary is the definite location of break in the track. The next question for consideration is the kind of structure which has washed or burned out; whether it be a trestle or truss bridge, length of the structure, depth of the opening, characteristics of the stream: as to whether there is likely to be water, mud, or sand to contend with. The superintendent of bridges should have the above information on file in his office, in order to enable him to determine to a great extent what kind and manner of temporary work will best meet the requirements.

If depth is not too great, opening may be cribbed up with ties; if very deep, it may be that temporary foundation for frame bents can be secured, but if bottom is soft and there is much water and current swift, frame bents or cribbing cannot be maintained, it may then be necessary to drive piles.

Front

These questions being disposed of, the next thing is to determine what débris is in the way of constructing the temporary structure: Is there a lot of cars in the washout, or an engine and cars? And if so, where is the wrecking outfit, how soon can it be brought to the washout, and how long will it require to clear the stream of the wreckage?

The necessary material for such temporary work, consisting of piles, stringers, caps, ties, sway-braces, plank, bolts, spikes, nails, etc., should always be stored at some convenient point on the line where it can be readily loaded on cars for such emergencies. The superintendent of the road should also have the necessary track ties where they can be loaded without delay.

The conductor's report in case of a wreck, in a washout or burnout, should be full and complete. The following form, now in use on the New York, Lake Erie & Western Railway, and some other lines, is copied from a paper read by Superintendent W. L. Deer, of the N. Y., L. E. & Western road, before the New York Railroad Club, and seems to embrace about all the information required:

..................Station..................189..

To................ Supt. Time Sent............M. Time Received.............M.

Train No...... .... Conductor..................

Engine .... Engineer....................

A. Time and place of accident. (State also if on main or side track, company or individual siding, at frog or switch, in fill, cut, or on level)...............
....

B. What caused it?...

C. Were any persons injured, and to what extent? Give name, age, residence, and occupation, and what was done with the persons?........................
....

D. Which track is obstructed, and which clear?..... ....

E. Which track can be opened first, and how soon?................................

F. What crossing-switches or sidings, east and west of obstruction, can be used to pass trains around?..
....

G. How long will it take to get track clear so trains can pass?..................

H. Will the derrick-car be required, and which way should it be headed to work to advantage?..
....

I. How much force is wanted to clear the obstruction?.........................

J. Is the track damaged, and to what extent? Have track-men been notified?
....

K. Is engine off track or damaged?..

L. What position is engine in?..

M. What position are cars in?...

N. How many cars broken and off track, loaded? (Give numbers, initials, and kind)..
....
....

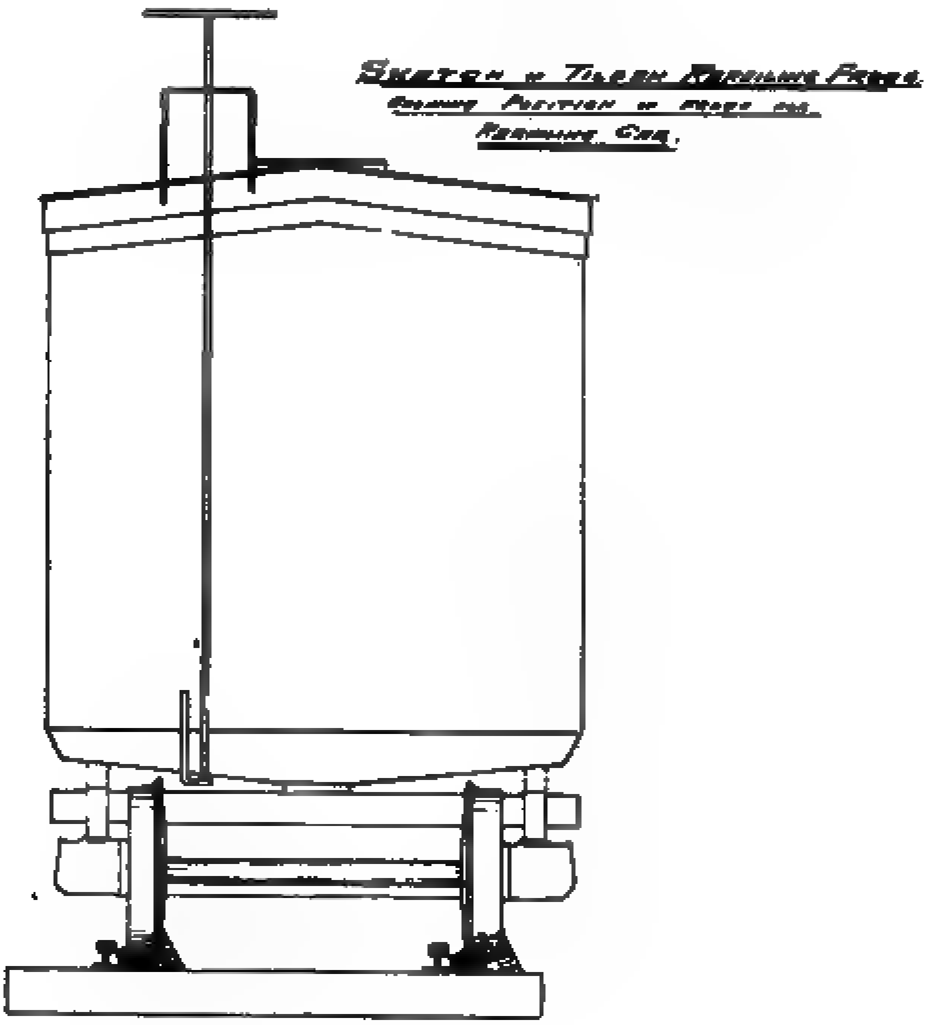
O. How many cars broken and off track, empty? (Give numbers, initials, and kind)..
....
....

P. How many cars and kinds are wanted to transfer freight in?..................

Q. What does lading cars consist of? What amount of damage to lading?....
....

R. How many cars next engine?...

S. How many behind cars wrecked?...


Sketch of Tilden Rerailing Frogs.
Showing Position of Frogs for
Rerailing Car.

T. How many car trucks needed? Give numbers of cars under which needed.

..

U. Can passengers be comfortably transferred around wreck?..................

V. How long will it take to transfer passenger train?..........................

W. What was the speed of the train?..

X. What was the state of the weather?...

Y. What trains, east or west, are stopped by the obstruction?..................

Z. Remarks...

..

SIGNATURE..

This information secured, the wrecking train and outfit is of the first importance, as no other work can be done until the wreck is cleared, or at least sufficient débris cleared away to enable the bridge gang to locate the temporary structure.

The wrecking train should consist of an engine, truck-car, tool-cars, and derrick-car.

The tool car provided for this purpose should be large and roomy—not less than nine feet, ten inches wide, and forty-four feet long—with seats enough for fifteen men. The balance of the room, arranged in the most convenient manner to store the tools. Hooks properly arranged along the sides of the car, the proper height from the floor to hang snatch-blocks, blocks and falls, hauling line, including any other tools which can be stored in this manner; for other tools, racks, boxes, and lockers should be arranged. A special place should be provided for hydraulic jacks, where they can be stored in an upright position.

After properly locating the seats for the men, and storing the tools, there will not be room enough left for a cooking outfit, which will have to be provided for in another car, yet there will be room enough for the men to eat their meals, which can be delivered to them from the most convenient boarding-house in lunch baskets or buckets.

The men can occupy this car on the road to a wreck. The car will require a heating stove, firmly anchored to the floor, to heat it during inclement or cold weather.

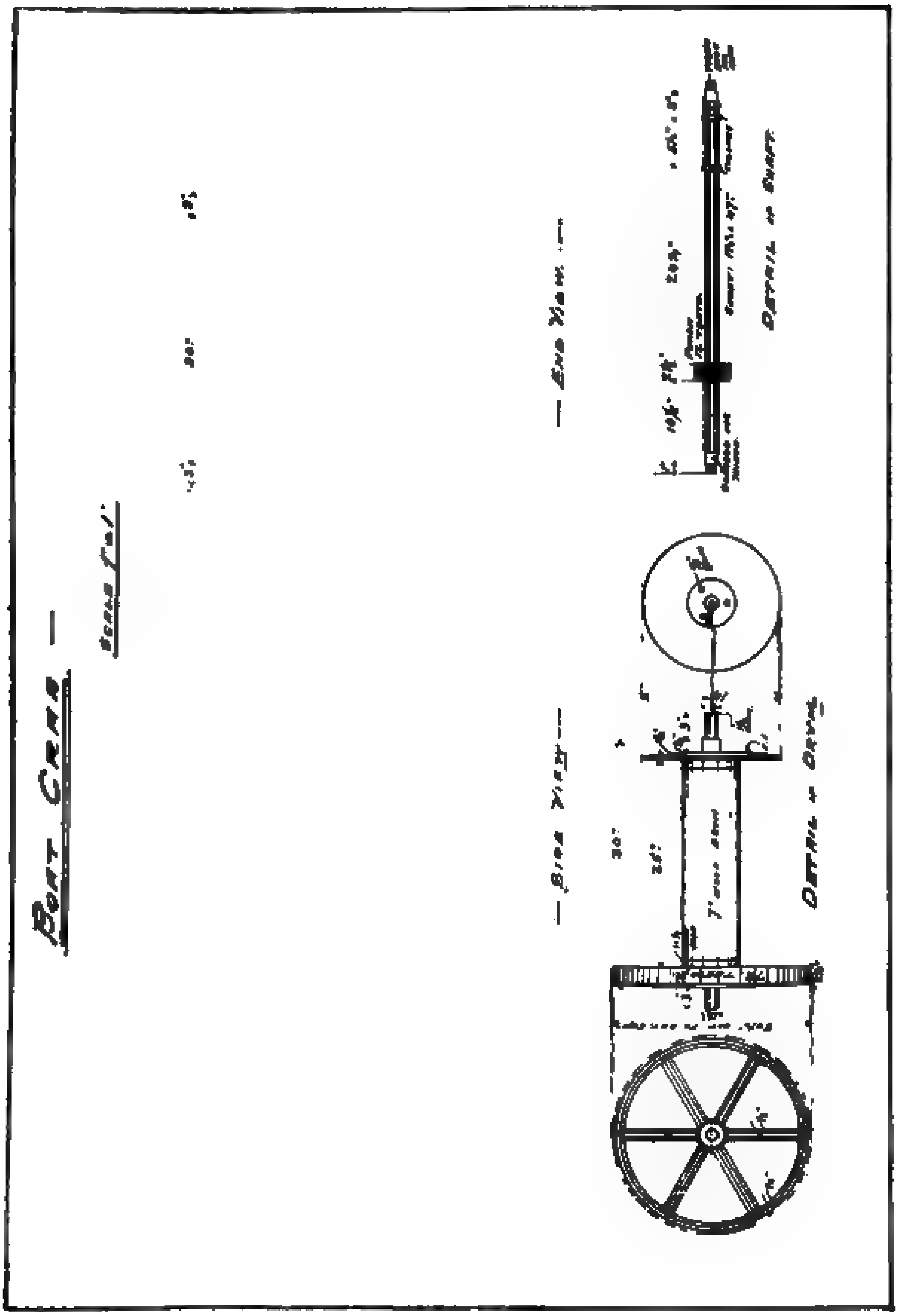
This car should be equipped with the following tools and wrecking devices:

Hydraulic jacks.—Five, from ten to thirty tons capacity, as follows: one ten-ton, two twenty-ton, and two thirty-ton. (The dudgeon jacks are considered equal to any other in the market, and are built from fourteen to twenty-four and thirty inches in height.)

Screw jacks.—Twelve, six twelve-inch, three eighteen-inch, and three twenty-four inches in height.

Manilla rope.—Two pieces, each 600 feet long, by two and one-half inches in diameter, two pieces 600 feet long two inches in diameter, two pieces 125 feet long, three inches in diameter, with link spliced into one end of each of them, with hook on other end of one rope, the other to have about eight feet of best one-inch crane chain with ring in one end and hook in the other; the ropes to be properly spliced into the ring of the chain, which must be provided with thimbles to keep ring from cutting the rope. The hooks on the chains are very useful on account of convenience in making hitches. Six slings, of best manilla rope, as follows: two one and one-half inch, two two and one-half inch, two three inches in diameter, one of each size should be six feet long, the other one and one-half inch eight feet long, and the remainder twelve feet long.

A one and one-fourth-inch plow steel wire rope, which has safe working capacity of about twelve tons, may be used to better advantage than a two and one-half-inch manilla rope. The snatch-blocks, however,


Boat Crane —
Side View
End View
Detail of Drive
Detail of Shaft

will require a larger sheave than for manilla rope, as sheaves for the wire rope should not be less than twenty-two inches in diameter at bottom of groove. In addition to above line, there will also be required enough rope for equipping blocks and falls.

Blocks and falls.—Four sets of the following sizes, one for one inch line, one for one and one-fourth inch, one for one and one-half inch, and one set for two inch line. All blocks having double sheaves of proper size to fit the line. Blocks with steel shells and iron sheaves are generally used for heavy work, such as turning over engines, and moving them into a position to be elevated to the level of track.

Blocks.—Two iron snatch-blocks for three inch manilla rope, two for two and one-half inch, two for two inch, two for one and one-half inch, and one extra set of double blocks for two inch line, one provided with becket.

Chains.—Six best charcoal iron crane chains, three three-fourths inch, and three one inch; the one inch chain to have a ring on one end four inches clear diameter, made of one and three-fourths-inch iron, and the three-fourths inch chain a like ring made of one and one-half inch iron, each chain to have a hook on the other end; two of the large chains should be sixteen feet long, and the other twelve feet, the three-fourths inch chains should be from eight to twelve feet long.

Switch ropes.—Two one and one-fourth inch plow steel wire switch ropes, one forty-five feet long, the other eighty feet long, each with link in one end and hook in the other.

Hooks.—Six double hooks, made of two inch iron.

Links.—Six links, from eighteen to thirty inches in length, made of one and one-half inch iron.

Wrenches.—Car should be supplied with wrenches of various sizes, including at least twelve monkey wrenches varying from twelve to thirty inches in length.

Steel bars.—Eight steel bars, varying in length from four to seven feet, shorter bars to be made of one and one-fourth, and others of one and one-half inch octagon steel.

Re-railing frogs.—Three pair of most approved design. (The B. E. Tilden frog, illustrated on print 3, is considered equal to any in use; there are other designs, however, which are very good.)

Hand crab.—One boat crab, as illustrated on print 4, will be found to be a very useful and convenient device for bridge gangs at a wreck. (It is the same design as used on board a vessel.) I have not found any of the modern designs which work any better than this one.

Wrecking crew.—The crew of a wrecking train should consist of fifteen men, including a wrecking boss, all of whom should have had some experience in this line of work; at least six of these men should be familiar with the use of hydraulic jacks, and all kinds of rigging. Two at least should understand how to splice ropes, make hitches and knots of the various kinds, such as timber, cat's-paw, Blackwell and half-hitch, single and double bow-lines, hand and flat knots; they should also understand how to coil lines in a neat and perfect manner. One of the best in this line should be selected and put in charge of wrecking cars when at the shop, or wherever they are kept, whose duty it should be to see that all rigging is in perfect order for emergencies, and in case a rope, chain, block, jack, or any other tool, has been broken or damaged at the last wreck, have it repaired or replaced. This man should be a good mechanic, and understand how to handle and repair hydraulic jacks and keep them in perfect order.

In case any of the ropes have been placed in the cars wet or dirty, they should be washed off, thoroughly dried, neatly coiled, and placed in their location in the car. All wrenches should be cleaned off, oiled, after which they should be wiped with waste, all surplus oil removed,

Sketch, showing Method Removing Debris from Wreck in Trestle with Steam Wrecking Crane.

and put in their place, as there should be a particular location in the car for each of the tools, and each of them placed there, to the end that any of the wrecking crew may go to the car, and pick up any tool at once.

The man in charge of the car should have a complete list of all tools which belong in the car, and should proceed immediately, after the wreck is cleared, to check up his tools, and in case any are missing, report them to the proper superior officer to be replaced. One member of this crew should be a competent, careful engineer, who is capable of handling the engines on the wrecking car.

The superintendent should look after the commissary for the wrecking crew. If they are not provided with a regular commissary car, their meals should be furnished to them at the work.

The wrecking crews on the Missouri Pacific Railway are in charge of the division master mechanics. On some lines they are in charge of the division superintendents, and on others, in charge of the road department.

It is my opinion that the master mechanics should have charge of the wrecking crews.

The derrick car for a wrecking train should be equipped with all necessary lines, blocks, rigging, etc. One of the latest and most approved designs for a car of this kind is shown on print No. 1, which gives position of steam wrecker, or derrick car, picking up a wreck.

The capacity of the car referred to is thirty-five tons, and it is manufactured at Bay City, Michigan, by the Industrial Works. The following is a general description of the car as given by Mr. Deer:—"The body of the car is constructed throughout of steel beams and channels. Main sills, six in number, four of which run from end to end of the car, are of eye-beams fifteen inches deep, fifty pounds per foot. Shorter sills are of twelve inch eye-beams, forty-two pounds per foot. Intermediate sills of twelve inch eye-beams, forty pounds per foot, and these, with the longitudinal sills, joined by plates and angles, are thoroughly riveted together. End sills are of white oak, ten by fifteen inches, bolted to one-half by fifteen inch plates, which are securely riveted by angles to the longitudinal sills. Frames so constructed give an entire length to the car body of thirty-seven feet, six inches, and a width of ten feet, four inches. The floor is of tongue and grooved white oak, laid in widths not exceeding four inches, with each plank fastened by four bolts to the longitudinal sills. The car body is further strengthened by four truss rods, two of which are inverted and one and three-fourths inches in diameter, with two inch turn buckle ends, the lower rods being one and one-half inches in diameter, with one and three-fourths turn buckle ends. The forward or crane end of the car is suspended from two equalizing frames, one on either side, which, in turn, rest upon the two front trucks; this arrangement distributing the weight and wheel base over a surface twelve feet long, and at the same time, accommodating itself to all curves, and allowing a speed otherwise impracticable. These equalizing frames are each constructed of two fifteen inch steel eye-beams, fifty pounds per foot, and nine feet, six inches long, boxed with forged connections to trucks.

The boiler is of flange steel, is fifty-two inches in diameter, and eight feet high. It has an upper combustion chamber. Power for hoisting and slewing the crane is derived from a pair of reversible engines whose cylinders are nine by twelve inches. A train of gearing from the engine shaft works three spools, the rope from one of which leads to a single sheave block attached to the crane jib for light and rapid lifts; another to a powerfully geared block on jib for heaviest

work; while the third and smallest is used for raising and lowering the jib as may be necessary in transportation. The engine is connected also with a system of gearing for slewing the jib in either direction twenty-two and one-half degrees from the centre of the track. All gearing is constructed of steel, and for the latter purpose is supplied with a device which securely locks the jib in any position during the process of lifting, this device also being most important for safety in handling the heaviest loads. The centre-post of mast supporting the jib of the crane is constructed of a Phoenix segmental wrought column, with an inside diameter of fourteen and one-half inches, and re-inforced at its base with encircling castings binding the whole together, and producing a section showing an outside diameter of some thirty-three inches, and possessing the greatest strength. It has a circular opening in its centre for the passage of the hoisting rope. The jib of this is constructed throughout of steel, and designed to have an effective radius of twenty-two feet from the centre of the crane post to the centre of the hoisting block. The main members of this jib are constituted of two beams with a depth of thirty inches at the base, and fifteen inches at the extremity. The webs of these beams are one-half inch plates running from end to end, with double three by three and one-half inch angles for the flanges, and further re-inforced by a top and bottom five-eighths by seven-eigthths inch plate. These two beams are connected by distance pieces, and partially covered by one-fourth inch plates bolted to the top and bottom flanges, making portions of the jib a box section. The webs of these beams are also strengthened by "T" irons riveted to their sides.

The jib is mounted upon four wrought "V" struts, two on either side, the forward of these being in compression, and the rear in tension when lifting, the bending movement due to the load being applied to the mast at a point about three feet above the deck of the car. By withdrawing the lower retaining pin from the back struts, the jib may be swung on the upper pin in the forward struts until it reaches a horizontal position, and one suitable for travelling. Replacing the pin in the upper hole of the rear struts holds the jib in this position. The jib, while being made tapering, is also constructed with a curved extremity, allowing material of large proportion to be raised to the full height of the jib, obviously a great advantage.

In case a derrick car is not to be had, other methods may be adopted one of which is to apply the torch to the wrecked débris, and burn it out. This may be done in extreme cases with good results, but it requires time, and after the wood is burned the iron is left to be either picked up with a derrick car or hauled out of the way with lines and crabs, or locomotive and lines. The quickest method to adopt is to use a locomotive and hauling lines, which is illustrated by print No. 2. If this method be adopted, the necessary snatch-blocks may be anchored to what are usually termed "dead men," properly planted in the ground; or anchored to trees if any be found convenient. The anchor usually adopted is the "dead man," which consists of a piece of timber about ten by twelve inches by ten feet in length, set horizontally in a trench about five feet deep, and parallel to the centre line of main track, and of sufficient distance from the wreck to haul out cars, trucks, etc., far enough to clear the site of temporary work. Commencing at the centre of the trench already dug, dig another at right angles to it, and about ten feet long, and slope it from the bottom of original trench to surface of ground toward the wreck. Pass a good one-inch chain around the centre of the timber, of sufficient length to lead up to the top of the ground. To this chain attach a snatch-block. Another anchor of the same kind should be placed in the ground near the track, to lead the line in

the proper direction so it can be attached to road engine as illustrated in print No. 2.

TO RAISE AN ENGINE.

To accomplish this, the first work or consideration will be to place the engine on its wheels; the next move will be to place it in proper line with the track which it is proposed to land it on. Every wrecking master has his own methods of arriving at the object desired. Hydraulic jacks are important tools for this purpose; hauling lines may also be used to good advantage in the same manner as illustrated by print No. 2. The method of elevating an engine by hydraulic jacks alone is a slow process; particularly is this the case when the height to be raised is great. Where the conditions are favorable a track can be built down an embankment, the engine placed on the rails, and hauled up the incline with one or more engines, by using a one and one-fourth inch steel wire switch rope to connect the live engine with the dead one.

In case the conditions are such as to make this method impracticable hydraulic jacks with a sufficient amount of blocking will be required. Blocking cut from sound old timber is the best, and should be cut into lengths from two to four feet, and of various sizes.

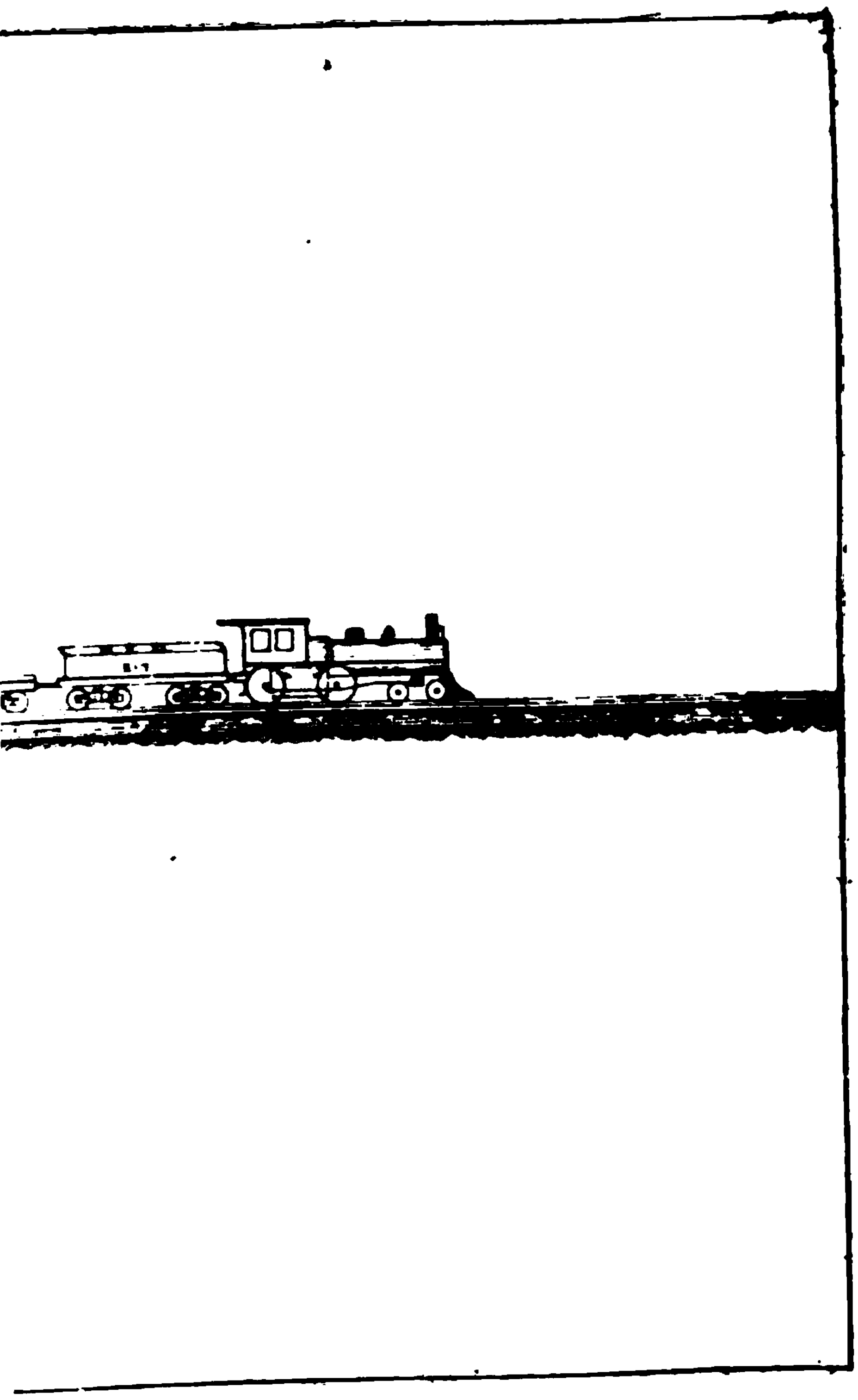
In case the location is on soft earth, a lot of blocking timbers should be cut from eight to twelve feet long, to make footings in the mud. The best size for this purpose will be seven by fifteen, or eight by sixteen, old stringers.

A lot of hard wood wedges about five inches wide, thirty inches in length, and three and one half inches thick at the large end, are very convenient for use when changing jacks.

After the wreck is cleared away the bridge force can proceed with the construction of the temporary trestle. The material is at hand, on the cars, ready for the work.

Let us suppose, in this case, that it is necessary to drive piles, as the water is deep, and the bottom soft. The pile car is switched into place, illustrated by print No. 5. The car represented in the cut is one used by the Missouri Pacific railway, has a clear reach of sixteen feet, which enables the use of a sixteen-foot panel, and so arranged that it will reach on either side of the track fourteen feet from the centre. The deck of the driver proper is fifty-five feet two inches long; the leads are forty feet high, and twenty and three-fourths inches clear between, are faced with eight-inch steel channels, and hang on hinges which enable them to be raised from a horizontal to a perpendicular position, and fastened in place, ready for service in eight minutes. Car is equipped with a three-thousand pound hammer, all the necessary ropes and tools, consisting of two one and three-fourths inch best manilla hammer lines, two one and one-fourth inch pile lines, with seven feet best half-inch crane chain, with ring in one end and hook in the other, line being spliced to ring of chain, and properly protected with steel thimble. Chain is used on account of liability of rope slipping, and is also much more convenient for making hitches for raising piles. The hammer and pile lines run over different sheaves and are connected to separate drums of the engine, which is situated back in the cab. The sheaves at the top of the leads over which these two lines are run, are nicely turned out, and made to fit the rope in perfect manner, as are the sheaves at the bottom of the leads; from these sheaves to the engine's drums the lines run over pulleys which protect them from chafing or damage by coming in contact with rough or sharp surfaces.

The engines of these cars are of the Mundy design, equipped with



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double drums twenty-two inches in diameter, and with double cylinders seven and one-fourth by ten inches; these engines have best approved friction gear, with link motion, and can be reversed or stopped in an instant, are strong, and free from accident.

The boiler is built of special design, extra heavy, forty-five inches in diameter, seventy-two inches high, with one hundred and twenty flues two inches in diameter; it being necessary on account of the limited height of the cab to keep the boiler down to seventy-two inches in height. A small amount of coal is stored in the cab; the principal supply, however, is carried by the convoy car, which is also provided with a water tank of two thousand gallons capacity.

This convoy is provided with a complete outfit of tools; consisting of one twenty-ton hydraulic jack, one half dozen screw jacks, two snatch-blocks for two-inch line, two for one and one-half line, one set of block and falls for one-inch line, one for one and one-fourth and one for one and one-half inch line, six hundred feet of one and three-fourths inch rope, one hand-crab, chains, wrenches, steel bars, pinch bars, adzes, spikes, nails, hauling lines, six sets of carpenter's tools and a limited number of framing tools, axes, etc.

The crew for this car for ordinary work consists of a foreman, engineer, and seven men, but for emergencies of this kind should have a crew consisting of twenty-four men, one-third good laborers, and the remainder bridge-men. This crew will drive five bents, four piles to each bent, cut them off, cap, place stringers, ties, and spike the track on them in ten hours.

The piles for the work, having been sawed off square at the butts, small ends pointed, closely trimmed, all projecting knots removed and pile rings fitted so that the first slight stroke of the hammer will drive them tightly on the butt of the pile, the road engine pulls the pile car back to where they are lying, where the pile will be picked up and taken out to be driven.

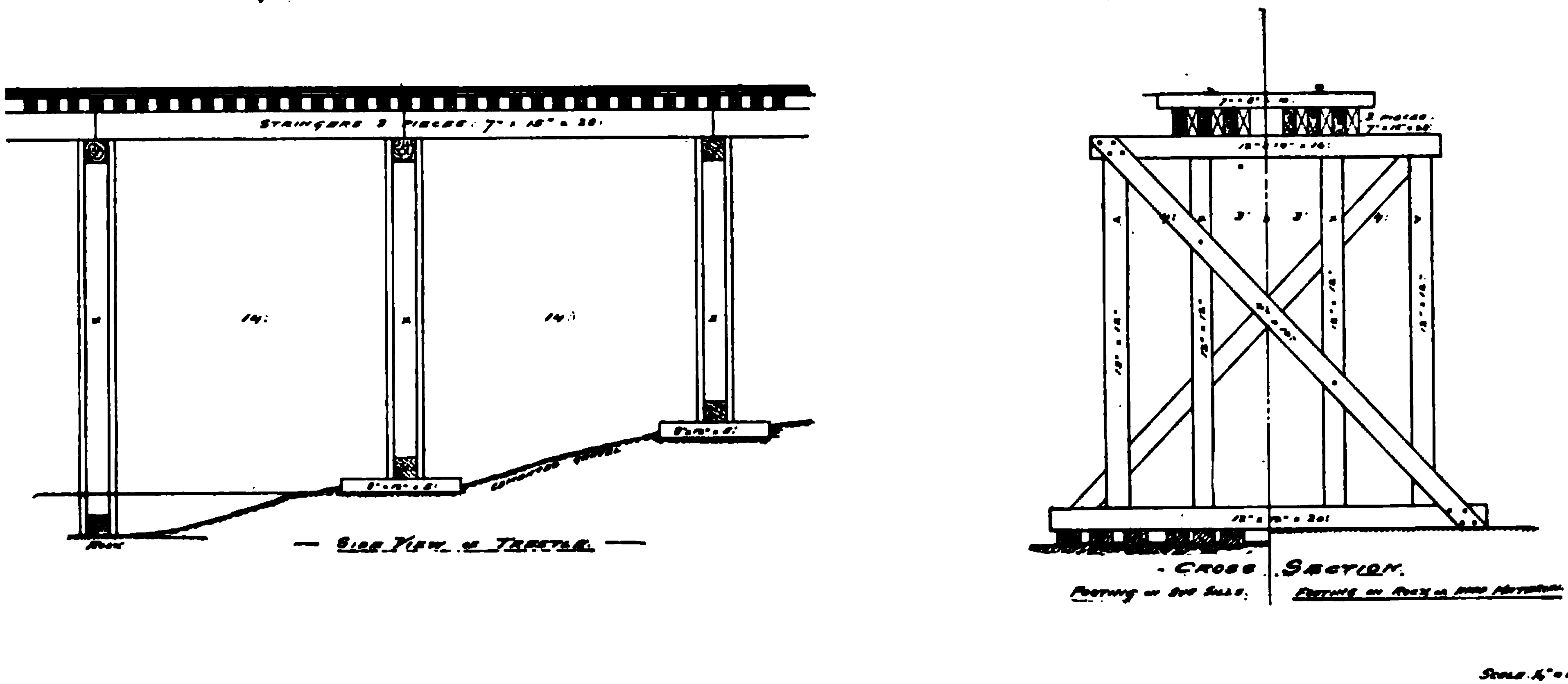
After piles have been driven and properly sawed off, caps, twelve by fourteen inches by fourteen feet long, will be raised into place with the pile lines; as soon as they are landed four men will climb upon them, each with an auger, and bore four holes through the cap (one over the center of each pile) others of the gang will have the necessary drift bolts (which should be seven-eighths of an inch round iron twenty-four inches long) together with a spike maul to drive them ready to hand to the men on the cap.

The stringers, six of them, eight by sixteen inches by thirty-two feet long (any other length can be used) are next hoisted into position with the pile line, and outside stringers drift-bolted to the caps; these in place, the ties (seven by eight inches by ten feet) are placed, and every third tie spiked to the outside stringer. The rails of the track are then extended ahead, firmly spiked into place, pile car moved ahead to drive another bent. This process will be repeated until the structure is finished. While the pile car is driving a bent, a portion of the gang will be at work placing the material for the next panel, where it can be readily reached by the car. In making changes from driving to sawing off piles, placing caps, stringers, and ties, it may be necessary to move the pile car back out of the way for a few minutes,

In case wash-outs or burn-outs should cover very wide openings in the track, and the importance of completing the repairs be great, every effort should be made to relieve the road from loss on account of detention of traffic. The only way to effect this is to increase the number of men and use two pile cars, one on each side of the stream, as indicated on print No. 5.

In case water is deep, it may be found convenient to employ the use of pontoons, which can be readily built of old pieces of pine or cypress

SKETCH OF FRAME TRESTLE FOR BRIDGING WASHOUT.



timber, such as seven by fifteen inches or eight by sixteen inches, stringers sixteen to twenty feet long, packed side by side, from five to eight feet wide, with plank deck spiked cross-wise on it after it is placed in the water. Such pontoons can be built to carry three or four men, can be anchored at any point required in the stream, and moved to the various positions with pike poles. I have often found these pontoons to be very serviceable, as men on them can guide piles to proper location, spike sway-braces to the piles immediately above the water, as well as greatly assist in handling the bracing.

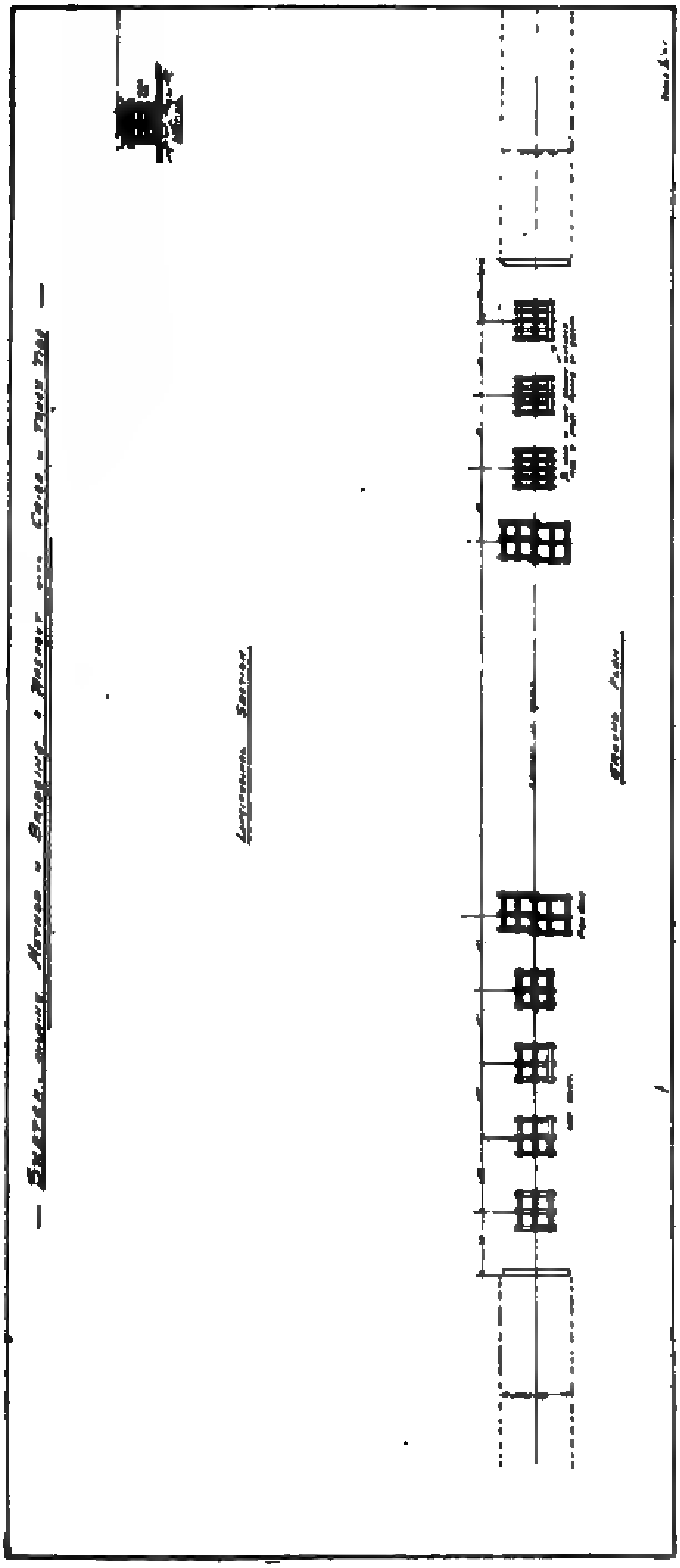
Where frame bents can be used I have found riprap stone of valuable assistance in securing a foundation, placing it where the bents are to be located, and, after a sufficient quantity has been placed, level it off and sills of the bent placed thereon. I have known bents located on foundations of this kind to remain in place several months without showing any signs of settling. Where frame bents, such as are represented in print No. 6, can be set without liability of settling, they can be constructed very much cheaper than any other kind and put in place much quicker than piles. They require to be well braced, however. I advocate the use of four by ten plank for the bracing, which is spiked to sill, posts, and cap with one-half inch boat spikes eight inches long.

There is another method of using frame bents where the bottom of the stream is comparatively solid and particularly where a rock bottom is found; this is to use twelve by twelve posts placed separately and of such length as will meet the requirements of an uneven or irregular bottom.

These bents can be framed together by securing the exact height where each post is to be located, after which cut the post to the required length, place them the proper distance apart, drift-bolt cap to the top ends, after which, spike a four by ten plank horizontally across the posts at a distance from the bottom, which will bring the plank level with the water surface when the bent is raised in place, after this spike a diagonal brace from the top of the four by ten plank across the posts and one end of the cap. This done, the bent is raised in place. After raising the bent, spike a four by ten plank on the other side of posts opposite the one spiked before raising the bent, also spike on another diagonal brace running in opposite direction to one on the other side.

This is not a quick process, but can be adopted where other methods can not be used to advantage. In case such a bent should settle to one side, add two more braces, and level up on cap.

If frame bents are used, the question of raising them must also be considered. A single mast or gin pole with four guy lines, one set of blocks and falls, can be used to good advantage. The mast should be located near the centre line of the track, and of the proper height for the work, two of the guy lines anchored near the track, the other two on the other side of the wash-out. The guy lines should be of the best plow steel wire rope, three-quarters of an inch in diameter, two of them two hundred and twenty-five feet, the other two, two hundred feet long. Before raising the mast, the upper fall block should be hooked in the ring provided near the top of the mast, the hook securely lashed with marlin to prevent it from being unhooked. After the mast is properly guyed into position, and the end of fall line fastened to the crab, which has been properly located and anchored, fasten a one and one-quarter inch line, having a double bow line in the center to hook the lower fall block into, to each end of cap of bent, and raise bent to a perpendicular position, adjust properly, brace longitudinally, after which other bents can be raised without changing location of mast, and this process continued until all bents are raised.



I may add here, that in constructing temporary trestles the stringers are usually placed on the caps without packing them together as in permanent work, and great care should be taken to see that the stringers do not move endwise, and pass off the cap at one end, which might result in a serious accident, provided temporary work is left in place for any considerable length of time.

Another method of bridging a wash-out is by the use of cribbing, constructed of ordinary hewn track ties. The method of building such cribbing is illustrated by print No. 7.

This is ordinarily considered a rude method of constructing temporary work, and is often built by men of little experience in constructing any kind of work, and is liable on this account to give trouble. But where cribs are built in a proper manner there is no reason why they should not be perfectly safe. The crib should be brought up as nearly level as possible, care being taken to select ties of the same thickness for the same course of the crib. In case the height is such that double cribs are necessary, the cribs should be capped with twelve by fourteen inches by fourteen feet long caps, using ties and stringers as in other temporary work, and securing them in the same manner. For cribs six to eight feet high, single cribs can be employed. For higher work I have found the method as illustrated on print No. 7 to admit of speedy construction, work better, and stand firmer, with less swaying than double cribs built separately. In building such cribbing, it is some times necessary, in case bottom is very soft, to lay a complete floor of ties for footing of the crib.

This method of bridging a wash-out is the most expeditious, as a large number of cribs can be built at the same time, and, in this way, enable a large force of men to work at comparatively good advantage.

Referring again to the use of engines and pile-driving machinery, more particularly to a comparison of the designs of machines, will state that I have not found anything in this line which excels the best designs of friction-gear engines.

There are two or three good designs of steam drivers, one in particular, which is manufactured by the Vulcan Iron Works of Chicago. I recall one of these which has been in use for a number of years, and works quite satisfactorily, but to say that it excels the best friction-gear engine is quite another question. We are quite satisfied with friction-gear engines, at the same time we will be glad to adopt anything that may be discovered which will perform the work more expeditiously, or show any improvement worthy of consideration. The steam hammer is, I think, better adapted to use on docks or floating drivers.

R. M. PECK.

Moved and seconded, that the report be spread upon the minutes. Carried.

REPORT OF METHODS AND SPECIAL APPLIANCES USED FOR BUILDING TEMPORARY TRESTLES OVER WASHOUTS AND BURNOUTS.

To the President and Members of the American International Association of Railway Superintendents of Bridges and Buildings:

As one of your committee to whom this subject was assigned, I respectfully submit the following:

First. Conditions governing physical features of the country on different railroads cause methods of repairing washouts to vary accord-

ing to the locality. Some parts of the country are subject to cloudbursts, while others more to high water from rains and ice, which also of necessity causes different arrangements in the organization of the bridge and building department. On some roads the bridge and building and roadway departments come under the engineering department. On some roads the roadway comes under the superintendent of the operating department, and the bridge and building department comes under the general superintendent. The reason for this is, that the superintendent of bridges and buildings, as a rule, can handle more territory than is allowed a division superintendent. Where the roadway and the bridge and building departments come under the same head, their relations are closer and therefore they can work in harmony, giving better results. The bridge and building department must have the assistance of the roadway and the transportation departments; the roadway in loading material and helping to make repairs; and the transportation department in furnishing cars for material and forwarding the same promptly to their destination, and also furnishing work trains, etc., as it is very important that traffic be delayed as little as possible on account of washouts and burnouts, and preparations should be made with this end in view, that any emergency may be met and promptly overcome.

Second. There should be material yards located at division and junction points where there are large bodies of men and where there are likely to be plenty of cars, so material can be loaded rapidly. The amount of bridge material that is carried in stock at these places should be governed by the number of lineal feet of bridges on that division of road which is subject to washouts and burnouts. There should be one principal material yard, and that should be located at some prominent division point nearest to the point material is received, where there should always be kept on hand a large supply of all kinds of bridge material. At the smaller yards there should be kept from five to fifteen panels of sub and superstructure, and some old bridge material, such as stringers twelve by twelves, and bridge ties, and also from five to fifteen panels of standard bridge hardware.

Third. During heavy storms section foremen should patrol their tracks and, as a rule, discover washouts. If discovered by a section foreman, he should notify the chief dispatcher and roadmaster. The chief dispatcher or roadmaster should notify the bridge foreman and also superintendent of bridges and buildings and the head of his department of break, giving details in full to the best of his knowledge. If only a small break, it can be repaired by the roadmaster and his men. If it is a bridge of a few panels, or a small fill, it can be repaired by the bridge foreman with the assistance of the section men.

All roadmasters at division points where material is located should have blue prints showing the material it takes for from one to thirty panels of bridge deck, and should also have a blue print showing material required for frame bents from eight feet up to fifty feet in height. This is to save long messages and chance of mistakes in transmitting.

In extraordinary washouts it is necessary to have material loaded at from three to five points, for usually there is not enough carried at one point, and in most all cases it is necessary to call on the roadway department to assist in loading.

Fourth. The superintendent of bridges and buildings in selecting foremen should make it a point to employ the best men possible, men who have had experience and display good judgment. They should be good all-round bridge and building men, which takes years of experience, and should be competent to do all classes of work in their department. They should be furnished with a complete list of plans of pile and trestle bridges, and should have blue prints showing bill

of material for from one to thirty panel of bridge deck complete. They should also have a bill of material for frame bents from eight feet up to fifty feet in height, showing sway braces and longitudinal and sash girts, and they should have the same for pile bents. They should have a blue print for framing bents, showing length of sills and distance between mortices and length of plumb and batter posts, so it will not be necessary for them to do any figuring in case of a rush. The superintendent should see that his foreman understand thoroughly how to make repairs with the material he has on hand, as the telegraph wires often go down and they cannot get instructions. The line may be washed out at a number of places, and the superintendent of bridges and buildings unable to get around on account of being busy at other points, when the foremen should understand that they are to act without instructions and use their own judgment.

The superintendent, supervisor, or general foreman of bridges and buildings should be a thorough mechanic, competent not only to instruct, but to do in detail any work he has in charge, and he should have a thorough experience in repairing washouts and burnouts.

Fifth. There are many different classes of washouts. In some instances embankments are washed out; in others, the fills are badly side washed, oftentimes from thirty to four hundred feet in length and from five to twenty feet in depth. Some fills are completely washed out, with large holes scooped out, and water two to twenty-five feet deep and in some places thirty to four hundred feet long. Pipes and arches are sometimes washed out with more or less of the embankment.

Bridges sometimes have the ends washed out; some have a few bents crippled only, and others are totally gone with from sixteen to four hundred feet of dump at each end of the bridge, and water running through the full length of the break. There are instances also where the track and bridges are washed out for miles. This is sometimes caused by insufficient water way, ice, or drift, but the majority of cases are caused by cloud bursts or extraordinary rains and cannot be prevented.

SPECIAL APPLIANCES.

Sixth. The best special appliance for making repairs to washouts is a first-class extension pile driver with the latest improvements, with a twenty feet extension, on a flat car with wrought iron Bay City, Michigan, turn-table with improved center and special turning gear and fastenings, these latter not furnished by them. It should turn completely around, and drive at any angle from the car or at either end of the car, and should drive twenty-six and one half feet at right angles from the center of the track, so that it will make no difference how it is located or in what direction headed; it will always be ready for work. It should be fitted with a double drum friction engine, and should turn by friction, air, or by hand.

The repairing of washouts is governed by the kind of break and the appliances on hand for such work. On some roads repairs are made of large washouts of fills and bridges where water from five to thirty feet has to be contended with, and not having a good extension pile driver it is necessary to crib. Where the work should be done in one day it takes two or three; besides there is a waste of material and labor caused by putting in temporary work when permanent work could have been put in in less time, and in any event the crib is unsafe on account of unevenness of ground; while with a pile driver the bridge is permanently rebuilt and men are ready for other work. Oftentimes it is not necessary to drive a bridge in washouts where

temporary frame bents can be put in, as it will be filled in again when convenient. In such places it is not necessary to use new material. There is no road but has more or less old material, and in such places all old material should be used. The principal object where cribbing must be done in water is to get material to sink the crib. Rock or rails are mostly used; but if none are convenient, it is necessary to have sacks to be filled with sand or dirt.

Seventh. In case of washouts the superintendent should have a complete detailed report as soon as possible, giving the location and extent of the different breaks, and if water is to be contended with, so that material can be ordered for temporary or permanent work, as necessary or advisable, old material being always ordered for temporary and new for permanent work. In case temporary work has to be put in where permanent work goes afterward, due care should be taken that the temporary work may not interfere with the permanent work.

In making repairs across streams where water is from ten to thirty feet in depth the following organizatiou is recommended: First. Unload enough material to start work. Second. Start a gang of men framing ties and one end of stringers and sizing both ends, sizing the end not framed back thirty inches. Third. Start pile driver to driving. Fourth. Have foreman and ten men in front. By the time the pile driver has a bent of piles driven the foreman has his staging up and height on the piles, and at the last blow of the pile-driver hammer the straight edge is put on and two men to each pile start sawing them off. While the men are sawing off the piling the driver has run back for a cap. When the piles are sawed off the pile driver lowers the cap to position and starts for stringers for one side. The stringers are lowered to position and the driver goes back for the other side. While the pile driver is gone men place stringers and finish drift bolting the cap. The other stringers are then lowered to position and the pile driver starts for a panel of bridge ties. As soon as bridge ties are lowered the driver goes back for two thirty-foot rails. These are placed on ties and the driver goes for a pile. Note, it is necessary to use two rails twenty feet long and two ten feet for temporary work. Thirty-foot rails do not always work to good advantage on fourteen and sixteen foot spans; they are either too short or too long, as the rails should project over the bridge. While it is gone the track is spiked, bolted, gauged, and lined up. At this point there is generally a few minutes' delay of driver waiting for men to get through. Then the driver starts driving the next bent. While driving this, two of the men in front are sawing off the ends of the stringers, getting ready for the next panel, and two of the men are detailed to bore and bolt up the stringers, so as to keep everything safe, and so it goes until the gap is crossed. I wish to state that of the ten men that work in front of the pile driver each man has his part to look after. While the pile driver is driving the next bent, one man should see that angle bars, track bolts, drift bolts, and tools are ready for the next bent. Two men sawing off stringers, five men putting up ledger boards and staging, putting on sway braces and bolting up same. The other two men are back boring and bolting up the chord. They should have turn buckles to pull bents square with the track and to pull the piles into place. All caps are bored out on the dump for sway brace bolts, and the gang there should do all the unloading, framing of material and piling same after framed for the pile driver to pick up. A foreman and nine men can do this and keep material prepared for a day and a night gang; note, one man should be detailed from this gang to file cross-cut saws for the pile driver and the two bridge gangs. There is no reason why, with proper management, they cannot drive and complete six to ten panels of bridge work every ten hours, and at

Ex "A"
[illegible] Bridge over Arkansas River
Dodge City

night three to five panels of permanent work. As the night gang has to do all the changing and coaling-up on their own time, there will necessarily be considerable loss of time to them and slower work on account of the darkness. If night work is done it will be necessary to have an extra engine tank for water for pile driver and locomotive. The locomotive should be arranged to take water from the pile-driver tank to avoid running for water from 6 a. m. to 7 p. m., or from 7 p. m. to 7 a. m.

In temporary work, where only three piles are driven to the bent, better results can be secured and fewer men are required.

There are roads that have bad washouts where it is necessary to crib in deep water, though they have a road driver that has an extension of six to eight feet. The writer recommends that they have two or three pieces of timber twenty-four by twenty-four inches by fifty feet, Oregon fir, and use them as stringers, projecting them over the cap ten feet or more and laying bridge ties and track thereon. The driver can be run out on them for driving a bent of piles, and every time one has been driven and capped the stringers can be readily moved forward to drive the next.

Repairs to embankments badly side washed.

There are several different ways of making these repairs. One is to dig down the remaining embankment and bring up the part washed to a level. It is necessary sometimes to make a long run-off, so that grade will not be too steep, as the fill cut down is often six or eight feet below grade. Another way is to build around the break what is called a shoofly. This is very often done, but it is not advisable except in extreme cases, as the cars are likely to run off the track, or the train to break in two parts on account of sharp curves and steep grades.

The following is recommended as the best way to make these repairs: Where embankments are half washed out and only ten feet deep lay one sill six by sixteen by ten feet longitudinal with track, set plumb posts on that, put caps on plumb posts, dig out bank and project caps through and place stringers under outside rail, resting on caps. The stringers carry the track on one side and the embankment on the other. Where the washout is eighteen feet deep set up a plumb and a batter post on sills and sway brace the plumb and batter posts to the cap. By putting in this temporary trestle work the track is up to grade, regular trains can be pulled, which cannot be done where embankment is cut down or shoofly is put in, and it can be filled by work train or steam shovel. If by steam shovel and side plow only a few section men will be required to handle the dirt: on the other hand, if shoofly is put in and filling is done with the steam shovel, it is necessary to scrape dirt off on one side and keep raising track up and throwing in line to get it back on its old centers and grade. This will require a large force of men and will cause a waste of material and delay of shovel unless they have other work in the vicinity. It is the same with embankment cut down, as a large number of men are required for raising and putting dirt under the track to bring it up to grade.

In large washouts, where road beds and bridges are washed out for miles, it is necessary to organize a track-laying outfit to work in conjunction with the bridge department. And it is often necessary to haul bridge material on wagons several miles ahead of the track to rebuild and repair bridges so they will be ready for the track-laying gang.

Burnouts are treated in a general way similar to washouts; but, as

Ex. "B"

PILE BRIDGE OVER ARKANSAS RIVER

DODGE CITY

a rule, there is no water to contend with, and driving can be started at one end and frame bents at the other.

Rapid repairs of washouts depend to a great extent on the number of men and conveniences for doing the work.

There should be boarding trains at all large washouts, or other arrangements made for the men to get their meals regularly. This should be looked after by the head of the bridge and building or roadway deartment, or by some one detailed by him.

All bridge gangs should have outfit cars, one bunk, one tool, and one material car, so as to be ready to move upon short notice.

I submit herewith exhibits of work.

Exhibit "A," showing pile driver driving an outside pile having one already driven. Bridge eight feet high.

Exhibit "B," showing ties just lowered on stringers and pile driver starting back for rails.

Exhibit "C," showing pile driver at washout driving a nineteen-panel bridge three hundred and four feet long in from fourteen to seventeen feet of water, bridge fourteen feet above water. Sixty feet east of the bridge this exhibit shows a washout in fill one hundred feet long and twelve feet deep.

Exhibit "D," showing methods of repairing side-washed embankments.

This method should not be used where embankments are over fourteen feet high without three ties fourteen feet long to each panel blocked up under the ends to support the track, and the soil then should be cement, gravel, or clay. It may be necessary in some instances to put in an extra plumb post to support the cap.

GEO. J. BISHOP,
Gen'l Foreman Bridges and Buildings,
C., R. I. & P. Ry. Co.

APPENDIX.

Organization of bridge and pile driver outfits.

Each bridge gang should have a bunk car, tool car, and flat car. On the material car should be carried one panel of bridge deck, a large assortment of 1, 2, and 3 inch lumber, and staging for cutting off piles for not less than 4 to 6 bents. Under the tool and material cars should be boots for carrying tools and supplies. In the tool car should be carried 6 to 10 panel of bridge bolts, 50 bridge bolts, and a large assortment of spikes and nails and the following tools:

1 hand car.
I push car.
1 velocipede car.
4 timber dollies.
1 track dollie.
1 hydraulic jack, 10 tons.
4 double-acting telescopic screw jacks 14 inches high. Ball's patent.
1 screw jack 8 inches high.
2 track jacks, Barrett No. 1.
1 medium size grind stone.
1 track gauge.
4 track chisels.
2 shackle bars for 7-8 inch bolts.
3 claw bars. Verona pattern.
6 octagon steel pinch bars, 1 1-4 in. x 5 ft. 4 in.
5 spike mauls.

Plan showing
Methods of Repairing Half Washed out Embankments

Section

2 8-inch double face hammers.
2 14-lb. double face hammers.
3 chopping axes, 4½ lbs. each.
3 clay picks.
12 maul handles.
6 sledge handles.
6 ax handles.
6 pick handles.
1 long handled shovel.
6 short handled shovels, No. 2.
2 lumberman's cant hooks without end spike.
2 post holes diggers, Eureka patent.
3 chisel bars 3½ inches wide, 1 inch thick, and 6 ft. long.
2 15-inch monkey wrenches.
2 track wrenches.
4 S. wrenches 2 ft. long for two kinds of 3-4 inch nuts, jaws 1 5-16 and 1 9-16 inches.
2 1-inch bridge augers with cranks.
6 7-8 inch bridge augers with cranks.
2 5-8 inch bridge augers with cranks.
7 cross-cut saws, 5 ft. long, with climax handles. "V" tooth 3-4 of an inch from point to point. H. Disston's patent.
6 8-inch flat mill files.
1 large size garden rake.
1 boring machine with 3 augers; one 1 inch, one 1½ inch, and one 2 inch.
2 5-8 inch chain spider, turn buckle 36 inches long, 2 5-8 chains 8 ft. long attached to turn buckle, with grab hooks on the ends.
1 ½ inch cable chain 14 ft. long, grab hook each end.
6 ½ inch cable chains 7 ft. long, grab hook one end, 3-4 inch ring 4½ inch in diameter at other end.
2 clamp bolts 1 3-8 inches, 36 inches long, threads cut 20 inches, 2 nuts each.
2 clamp bolts 1 3-8 inches, 44 inches long, threads cut 20 inches, 2 nuts each.
4 cranks to fit nuts on clamp bolts.
8 wrought washers 5 x 5½ inches, 1½ inch hole.
4 staging hooks 5 ft. long, hooks 8½ and 12 inches.
3 pike poles 16 ft. long, 1 3-4 inches one end, with ferule; other end 1 1-4 inches, select yellow pine.
2 16-inch poles 1 1-4 x 1 1-2 inches, select pine, S. 4. S.
6 straight edges 16 ft. long, 1 1-4 inches thick, and 10 inches wide, full length, select pine.
2 10-inch double blocks, Hartz' patent steel.
2 8-inch double blocks, Hartz' patent.
1 10-inch snatch block, Hartz' patent.
2 hand lines 50 ft. long, 3-4 inch rope.
100 ft. of 1½ inch rope.
250 ft. of 1 inch rope.
150 ft. of 3-4 inch rope.
6 lantern frames.
6 white globes.
3 red globes.
6 red flags.
12 green flags.
24 track torpedoes.
4 2 gallon oil cans, 2 gallons coal oil, 2 gallons black oil, 2 gallons signal oil.
1 1-quart oiler with short spout.

2 water pails.
1 broom.
1 water keg.
1 wash basin.
1 dipper.
3 torches.
1 No. 3 Merrill's saw set for single tooth cross-cut saw.
1 5-8 octagon steel drift 16 inches long.
1 5-8 inch octagon steel drift 24 inches long.

Pile driver outfit organized and supplied with tools, etc., as follows:

Train crew:
Conductor.
2 brakemen.
1 engineer.
1 fireman.
Pile driver crew:
1 foreman.
1 engineer and 6 men.
1 engine.
1 caboose.
1 bunk car.
1 tool car.
1 flat material car.
1 flat car 3 ft. high and 30 ft. long, to go under extension of pile driver.
1 twenty ft. extension pile driver.
1 pile driver water tank with connections for road engine.

Description of pile driver as follows:

Length of flat car, 32 ft. 4 in.
Width of flat car, 9 ft. 10 in.
Length of flat car, including draw heads, 33 ft. 6 in.
Size of axles, 5 1-4 x 9.
Size of journal brasses the same.
Distance from center of turn table to ends of car, 16 ft. 2 in.
Length of pile driver over all when leads are raised, 61 ft.
Width of pile driver over all, 10 ft. 2 in.
Length of engine room, 26 ft. 10 in.
Height of engine room from floor, 7 ft. 9 in.
Length of platform outside of engine room, 18 ft. 4 in.
Length of angle to nose of driver, 16 ft. 10 in.
Height from top of rail to top of head block on leads, 36 ft.
Length of leads, 35 ft.
Size of leads, 7 x 9 oak.
Size and length of channel iron on leads, 2½ sec, x 7 sec. x 32 min.
Distance between leads, 20½ in.
Diameter and width of pulley on 20 1-2 x 2 7-8.
Weight of pile driver, 86,600.
Weight of pile driver on rear trucks, 41,600.
Weight of pile driver on front trucks, about 45,000.
Weight of pile driver with leads raised, about 48,000.
Weight of hammer, 2,800.
1 friction pile driver engine, Lidgewood Mfg. Co., No. 72, 30 horse power.
Boiler 42 in. diameter, 96 in. high, 48 ft. of the top swelled out to 48 in. diameter.
Driver should have solid wrought iron turn-table 10 feet in diam-

eter, and should turn completely around. It should be capable of driving 20 feet ahead of the track and 26½ feet at right angles from center of track. It should be fitted to turn by friction, air, or hand. Duplicate parts should be carried for whatever is likely to break or give way; also a complete outfit of tools, as follows:

2 15 ton hydraulic jacks.
4 telescopic, double acting screw jacks 14 inches high. Ball's patent.
3 track jacks, Barret's No. 1.
1 grind stone, medium size.
2 shackle bars for 7-8 inch bolts.
4 claw bars. Verona pattern.
6 octagon steel pinch bars, 1 1-4 inch x 5 feet 4 inches.
1 track gauge.
4 spike mauls.
2 8 lb. double face hammers.
2 14 lb. double face hammers.
4 clay picks.
4 chopping axes, 4½ lbs.
12 spike maul handles.
6 sledge handles.
6 clay pick handles.
12 ax handles.
2 long handle shovels.
6 short handle shovels.
6 lumberman's patent cant hooks.
2 15-inch monkey wrenches.
4 S. wrenches 2 feet long for two kinds of 3-4 inch nuts, jaws 1 5-16 and 1 9-16 inches.
2 track wrenches.
2 1-inch bridge augers.
6 7-8-inch bridge augers.
2 5-8-inch bridge augers.
4 5-feet cross-cut saws, "V" tooth 3-4 inch from point to point, with climax handles. H. Disston & Sons' patent.
12 8-inch flat files.
2 clamp bolts 1 3-8 x 36 inch threads cut 20 inches, 2 nuts each.
2 clamp bolts 1 3-8 x 40 inches, threads cut 20 inches, 2 nuts each.
2 clamp bolts 1 3-8 x 44 inches, threads cut 20 inches, 2 nuts each.
6 cranks to fit nuts on clamp bolts.
12 wrought washers 5 x 5 inches, ½ inch thick, with 1½ inch hole.
4 pile clamps 6 x 10 x 16 pine. S. 4. S.
2 5-8 inch chain spider turn buckles 36 inches long, with two 5-8 inch chains 8 feet long attached to each turn buckle, with grab hook on one end.
2 1-inch cable chains 16 feet long, grab hook on each end.
4 3-4-inch cable chains 16 feet long, with grab hook on each end.
1 3-4-inch cable chain 18 feet long and grab hook each end.
1 5-8-inch cable chain 14 feet long, grab hook each end.
2 5-8-inch cable chains 8 feet long, grab hook each end.
2 5-8-inch cable chain 4 feet long, grab hook each end.
2 20-inch wooden double blocks with large ring.
2 16-inch Hartz' steel double blocks with rings.
2 12-inch Hartz' steel double blocks with hooks.
2 8-inch Hartz' steel double blocks with hooks.
2 12-inch Hartz' steel single blocks with hooks.
2 8-inch Hartz' steel single blocks with hooks.
4 18-inch Hartz' steel snatch blocks with rings.
2 14-inch Hartz' steel snatch blocks with hooks.

2 12-inch Hartz' steel snatch blocks with hooks.
2 10-inch Hartz' steel snatch blocks with hooks.
1 bail of 2-inch manilla rope.
1 bail of 1½ inch manilla rope.
1 bail of 1 1-4-inch manilla rope.
400 feet of 1-inch manilla rope.
400 feet of 3-4-inch manilla rope.
24 toggle blocks 4 x 6 inches x 4 feet oak. S. 4. S.
2 toggle irons, top front.
2 toggle irons, bottom front.
2 toggle irons, bottom back.
4 pike poles 16 feet long, large end 1 3-4 with ferule; the other 1 1-4, common select yellow pine.
10 18-inch poles 1 1-4 x 2 S. 4. S. Second clear pine.
12 straight edges 16 feet long, 1 1-4 inch thick, 10 inches wide, full length. Second clear pine.
6 pile rings, 12 in. inside diameter.
10 pile rings, 14 in. inside diameter.
16 pile rings, 16 in. inside diameter.
20 pile rings, 16 in. inside diameter.
25 pile rings, 18 in. inside diameter.
4 staging hooks 5 feet long, hooks 8½ and 12 inches.
2 kegs of 10-inch boat spikes.
2 kegs of track spikes.
2 kegs special track bolts with loose nuts.
2 kegs 60-penny nails.
1 keg 30-penny nails.
1 keg 10-penny nails.
2 steel rails 4 1-4 in. high, 20 feet long.
2 steel rails 4 1-4 in. high, 10 ft. long.
1 marlin pin.
1 car couplin 20 ft. long.
6 lantern frames.
6 white globes.
3 red globes.
6 torches.
1 locomotive headlight.
1 Lucigen lamp with hand compressor and fifty feet of hose, 1,000 candle power, made by Industrial Light Co., New York.
12 red flags.
12 green flags.
2 water kegs.
2 dippers.
2 wash basins.
24 track torpedoes.
12 fusees.
1 No. 3 Merrill cross-cut saw set.
1 octagon steel drift 5-8 x 24.
1 octagon steel drift 5-8 x 16.

List of tools for pile driver engine.

1 1 3-4 lb. hammer.
1 1 1-4 ball pien hammer.
1 15-inch Stillson wrench.
1 15-inch monkey wrench, Coe's patent.
1 10-inch monkey wrench, Coe's patent.
1 small steel wrench for eccentric bolts 5-8 and 3-4 jaws.
1 small steel "S" wrench, 3-4 and 1 inch jaws.

1 cold chisel 3-4 x 8 inches.
1 cold chisel 1 x 8 inches.
1 pair pipe tongs, 3-8 to 1 inch pipe.
1 pair pipe tongs, 1 to 2 inch pipe.
1 key punch.
1 packer ratchet.
4 drills, 1-2, 5-8, 3-4, and 7-8 inch.
1 half round file, 16 inch.
1 flat mill bastard file, 16 inch.
3 lbs. sheet lead.
3 lbs. sheet rubber 1-8 inch thick.
3 lbs. sheet rubber, 1-4 inch thick.
2 lbs. asbestos packing, 5-8 inch round.
1 ball candle wicking, 1-4 pound.
12 gauge glasses.
12 lubricator glasses.
24 hand hole gaskets, 3 3-4 x 4 3-4.
2 1 quart oilers.
1 tallow pot.
15 lbs. tallow.
5 gallons coal oil in can.
3 gallons black oil in can.
3 gallons engine oil in can.
3 gallons signal oil in can.
1 coal pick.
1 ash hoe.
1 fire hook.
1 scoop shovel.
100 feet of 1 inch steam hose.
½ dozen 3 inch hose clamps.
½ dozen 1 1-4 inch hose clamps.
200 feet bell cord.
12 pinion keys.
1 steel key drift 16 inches long.
5 lbs. waste.

The above valuable paper was received too late to be read in the convention, but is entered as part of the Proceedings.

No. 4—"Best Method of Erecting Plate Girder Bridges."

BEST METHOD OF ERECTING PLATE GIRDER BRIDGES.

RICHMOND, VA., May 8, 1895.

We, as superintendents of bridges and buildings, and committee appointed to write of this subject, know how essential it is to have girders erected as cheaply, with as little delay to traffic as possible. I will first discuss the manner of erecting girders on new roads, with which I have had a good deal of experience: I erected four 51, two 44, and one 69 foot deck plate girders on a new road where track was being laid. Girders arrived before track had reached the bridge site, were unloaded on scaffold, level with floor of car. I then had them riveted up complete, framed ties and guard rails all ready to put on, then put up temporary trestle to enable them when they reached bridge site to push over cars of rails and ties sufficient to give them employment for at least one day after this. I then loaded girders on flat cars, run them out over opening, set jacks under them, took the weight, pulled cars from under them, took away false work, then

slacked them down to the proper place. In doing work after this method it affords an elegant opportunity for good riveting, and the track force experiences no delay whatever with their work. This is a very economical way, as it requires no engine, traveler, or rigging, only four jacks to handle girders.

On main line, or where traffic is to be contended with, it is impossible to adopt any regular plan by which to put in new girders, but you have to be governed by location and surrounding circumstances. I erected several girders on main line where trains were running regularly, in the following manner: I received a 70 foot deck plate girder for an opening where abutments had been extended for double track. Siding was near bridge. I did not unload girders, but jacked them up on cars, riveted them up complete, had cars pushed out on main line opposite the place for which they were intended, took the weight, had cars pulled out, slacked girders down on two greased rails, pushed them out over crib of blocking clear of main line, and lowered them down into proper place with jacks. This was done very successfully and cheaply, requiring no false work or rigging, only four jacks, as in the case mentioned above. This work was done with regular road force of eight men.

Thirdly, I erected a deck plate girder on double track, both main lines. Girders were 50 foot each and were made the same as two single track girders, and askew. Not having room on side of bridge to put them together, I was forced to do this at the end of the opening. Being at a place where I could get one track for six hours, I greased the rails, pulled the girders out to proper place, took off rails and deck, cut down piling, slacked girders down into proper position with jacks. Both girders were put in place complete, on same plan, without any delay to trains. Expense of labor, $212.00.

Fourthly, I put in a double track through plate girder span, 65 feet long. This was a very heavy span, three girders, center 8 ft. 2 in. high, two outside ones 6 ft. high. The span was askew, and, consequently, more difficult to erect. Only one track was in use, which was on piling, the grade being ready for the other track. To avoid blocking the main line while unloading, I cut the track, ran cars off on new grade, put up two bents of trestle, laid stringers across with rails on them and then pulled girders off cars endwise on their flat across the opening with crabs. They were then set up with jacks and riveted in floor system for one track then in use. Old structure was then taken out and girders pulled into position with crabs. Having accomplished this I then unloaded the other girder after the same plan and finished it up complete for the other track. Twelve men did this at a cost of $560.00 for labor.

The last girder which I shall mention was a 53 foot three-track through plate girder. Stone work was built for five tracks, but only two were being used, and they were on piling. I unloaded all girders from cars down on abutments, riveted them up for two tracks then in use, and put ties on both spans complete and ready for rails. These were pulled into position in the same manner as those referred to above. Girder for third track was then adjusted and the whole job was executed by fourteen men at a cost of $384.00 for labor.

When bridge companies put in girders they almost invariably block the track and delay trains, I think, unnecessarily. This, in most instances, is attributable to their not getting everything ready in advance. In this lies the secret of erecting girders successfully and economically. No man can hold onto a good reputation as a bridge man on the Chesapeake & Ohio Railway if he stops the "yellow cars."

J. M. STATEN,
General Inspector of Bridges.

Moved and seconded that the report be received and spread upon the minutes. Carried.

Mr. Andrews.—Before going into the discussion of the reports, we will have the report of the executive committee. Report read by Mr. Cummin, and ordered spread upon the minutes.

REPORT OF EXECUTIVE COMMITTEE.

Your executive committee would respectfully present the following report:

1st. Mr. B. F. Bond having paid up all back dues and requested reinstatement, we would recommend that his request be granted.

2d. It has come to the notice of this committee that there is a difference of opinion among the members of this Association, in regard to the authority of this committee to change the place of meeting designated by the Association. Your committee would suggest that action be taken by the Association at this meeting to settle this particular question for all time.

Mr. Shane.—I would like to inquire as to the authority of the executive committee in regard to meetings. Such an emergency may arise another year; while the action of the committee in changing the place of meeting may have been a wise one, yet I think the question should be taken up. It is a matter that I do not want postponed until after a large number of the members have gone home; I want the sense of the association, and therefore move that the action of the executive committee in changing the place of meeting was not vested in them by the constitution.

After discussion it was decided that the constitution sustained the executive committee in changing the place of meeting, by resolution offered by Mr. Shane and unanimously carried.

Report of nominating committee read by Mr. Markley; received and ordered spread upon the minutes.

We, the committee appointed to nominate officers for the coming year, beg leave to make the following report:

President—W. A. McGonagle.
1st Vice-President—L. K. Spafford.
2d Vice-President—James A. Stannard.
3d Vice-President—Walter G. Berg.
4th Vice-President—Joseph H. Cummin.
Secretary—S. F. Patterson.
Treasurer—George M. Reid.
Executive Members—A. S. Markley; W. M. Noon; J. M. Staten.

Mr. Andrews.—The reports of committees on selection of subjects and auditing not being ready, we will proceed to the discussion

of reports of committees at our last annual meeting. All the members have received copies of our proceedings at the last annual meeting, and have had ample time to study out the various questions therein and we feel that they can now be taken up properly and intelligently.

Mr. Berg.—I move that the discussion of last year's subjects be limited to fifteen minutes each, unless by vote of the association the time be extended. By doing this, we will be aided in getting through our work, and at the same time offer an opportunity to each member to bring up any point he may wish. Carried.

Mr. Andrews.—Report of last year on "Depressed Cinder Pits" is now open for discussion.

Mr. Berg.—In regard to cinder pits, I desire to place on record in our proceedings some additional information which I have collected during the year.

There is a hydro-pneumatic ash ejector, described and illustrated on page 602 of the December, 1893, issue of the *American Engineer and Railroad Journal*, in use on ocean steamers, the principle of which might be utilized to remove ashes out of a deep pit where a suitable water pressure and subsequent drainage is obtainable.

In the committee's report on "Depressed Cinder Pits," presented at the last convention, the gravity cinder chutes of the Southern Pacific Railway at San Luis Obispo, Cal., were described on page 54 of the "Proceedings of the Fourth Convention." These chutes were at that time not in actual operation. Since then they have been put in use and Mr. William Hood, chief engineer, Southern Pacific Railway, wrote on December 13, 1894, that these chutes are working most successfully. He states further, that "the engines are handled as usual by hostlers, who clean out the engine ash-pans in the usual manner. Generally they clean several engines before washing out the ash-pit chutes, leaving the ashes accumulating until the chutes are about full. The hostler, at any time he finds convenient, then washes out the accumulated ashes from the chutes into the dump car, which stands on the dropped track. If each 2 in. valve at the upper end of the pockets is opened full and at once shut, the ashes will have been moved into the dump car from the chute served by that particular valve during the process. The water pressure is about 80 lbs. There is very little water used and the hostlers do the work of handling the valves along with their other duties."

It would also seem desirable to record that the Southern Pacific Railway has introduced at Oakland, Cal., during the past year, automatic buckets for handling cinders, which, according to my informant, "save one-half the labor required originally for shoveling."

Mr. Markley.—It is not desirable to allow the ashes to remain in the pit while three or four engines are run through. Where the pits are built of stone, the intense heat that accumulates from these ashes is very liable to injure the stone, and will

in a very short time cause them to deteriorate and burst from the heat and cold water together. We have had that experience where we had erected them of sand-stone. Where the stones get extremely hot and then have cold water poured on them, they will eventually crumble to pieces. We always clean the ashes after each engine, turning a hose into the ash-pan and extinguishing nearly all the fire in the ashes. As to that particular part of the report, quoting from the chief engineer of the Southern Pacific Railway as to their practice, I think there is a defect in that they allow several lots of ashes to accumulate before they sluice them down the chute into the dump car.

Mr. McNab.—If you tried sluicing ashes down into a car in cold weather, they would freeze. It would never do in the neighborhood of Chicago.

Mr. Peck.—I would like to know if the trouble from stone being damaged by heat cannot be overcome by lining with brick, and if so, if it would not be economical?

Mr. Berg.—It can with good fire brick; but I question whether any character of brick would stand heat and cold together. I consider the lining of pits with fire brick would prolong the life of the pit, but I personally doubt whether it is practical railroading, because fire brick come very high; at least in the eastern section of the country. And then the men in the pit shovelling will damage the brick.

Mr. Eggleston.—Within the last two years we put in an elevated ash pit, with hard brick, and then a coat of cement. It is standing there to-day, as good as ever. We turn half a dozen engines in there at a time. I do not think sluicing would do in the north; it would freeze.

Mr. Berg.—I would like to call on Mr. Heflin to say why the proposed cinder pits with water sluices were not put in on his road in West Virginia. Any physical reasons why they were not put in?

Mr. Heflin.—I do not know really the reason why it was not put in; I ordered the iron for the sluice chutes and received it, but pending the time to do the work, the iron was ordered away, and the work is just as it was this time last year; but I would say that I do not see how the heat could affect the stone, if the sluice chute is put in in the manner we proposed to do it, as it would be impos-

sible for the ashes to come in contact with the stone. Whether this sluice pit will be finished in the future, I am unable to say.

Mr. Markley.—Another thing to be taken into consideration is the value of the water. In Chicago and other places, where we get water from the water works, we are obliged to pay eight and ten cents for it, and it would be a question whether the value of the water would overcome the advantages of the pit.

Mr. Berg.—I would quote from a letter received from an official of the Southern Pacific, that by opening a 2 in. valve once full and then turning it right off again, the amount of water that would pass through,—there being a valve for every four feet run of the chute,—will clean the entire contents of the chute.

So it cannot take very much water,—water pressure force of 80 lbs.

"Best method of Bridge Inspecting."—No discussion.

Report on "Maintenance of pile and frame trestles."

Mr. Markley.—I would like to hear from some of these southern gentlemen, in reference to creosoted piles.

Mr. Mallard.—We are using creosoted piles. At Morgan City we have a bridge about 1,700 ft. long, with very long piling,—some 135 ft., spliced. We have the piles examined every year by a diver. The part that is under water is perfectly solid. So far, I have known of only two piles that show the least signs of decay; the decay seems to be where the sap had been shattered loose from the heart by the hammer. I think the L. & N. have some piles that are 17 and 18 years old.

Mr. Markley.—I would like to ask the cost of creosote, per lineal foot of piling.

Mr. Mallard.—It depends entirely on the amount of creosote. It runs all the way from $22.00 to $26.00 per 1,000 ft. board measure. I think piling cost $27.00 to $30.00. We have our own works at Houston and of course get ours cheaper. On pile trestles of 15 ft. centres we make a floor of creosoted 10x12, then 8 in. of gravel on top of that, making a continuous road-bed. The L. & N. started the use of creosoted timber about 19 years ago. I think about three years ago, they examined some of the trestle; found them perfectly sound after 15 or 16 years. In response to

an inquiry as to use of stringers on 15 ft. openings and covering with gravel, Mr. Mallard stated it rendered travelling easier and reduced the danger from fire, gives a continuous road-bed and is estimated to last 25 years.

Mr. Stannard.—It will require a great deal of time when you come to renew them; it will cost as much as not using gravel; of course, it reduces danger from fire. The K. C., F. S. & M. use a 2 in. plank between the tie and stringer, filled in between with gravel, using 2x6 spiked to tie, to prevent the gravel from running out to prevent danger from fire.

Mr. Markley.—In coming over the Illinois Central, I noticed some of these openings and could not understand the advantage; it would seem that the timber would rot if not protected. In our country we have to commence renewing bridges when they are five or six years old.

Mr. Mallard.—We will leave the solution of these questions to future generations. The gentleman overlooks the fact that on portions of our road we have openings every 100 to 200 ft. They have the old French system of giving one man so much water. Every man has to have his water under his own control,—for raising rice. By this continuous road-bed, you have smooth riding track.

Mr. Berg.—When the creosoted timber is used, I presume it is perfectly proper to let the maintenance question remain for future generations, as mentioned by Mr. Mallard.

Mr. Cummin.—I simply want to say that there is a gentleman here who is not a member, but I think can give us some very valuable information, if he was called upon,—Mr. Collbran of the Atlantic System of the Southern Pacific.

Mr. Andrews.—We would like to hear from Mr. Collbran, and shall be obliged for any information he can give.

Mr. Collbran.—The first creosoted work that I put in in this section about twenty years ago is still in. Mr. Mallard has mentioned that we have a good sample of the class of work which we call a ballast deck. Our object in putting this in specially is to make a continuous track and prevent the bob or jump at the end of each little opening. There are no bridges in the section of swamp country on which the approaches can be kept up without continuous work. We have a great number of continuous decks, which we use from here to El Paso. I suppose that our percentage of creosoted

timber, New Orleans to El Paso, is about 35. The economy is being demonstrated to-day by the amount of timber we use each year. The first work done in this section of the country was on the New Orleans & Mobile, now the L. & N. R. R. The first work was in 1876, twenty miles from New Orleans; the piles under the bridge are to-day the same as when the work was done. I have never yet taken out, in something over eight years, a stick of creosoted timber on account of rot. I have seen a few rotten creosoted timbers, but I considered same due to defects. If it commences to rot before you treat, it will not stop. We use it also in piling piers altogether in this country. I thank you, gentlemen, for your consideration.

Report on "Best track scale foundation."

Mr. Heflin.— I do not suppose that any one will dispute that a good stone foundation is the best for track scales. I know of one that was put in 35 years ago, still good yet; has never had any repairs. Of course, it depends somewhat on the earth you have. Never have had any trouble about a foundation in my section.

Mr. Andrews.—For the benefit of the gentlemen who have not read these reports, will state the majority report they favor a stone foundation, and the minority report condemns it.

Mr. Mallard.—What are you going to put under your stone foundation; dig down here three feet, in this section of the country, and you get a well.

Mr. Markley.—We have on the line of our road some twelve or fifteen track scales. There is not one of these twelve or fifteen that have a stone foundation. We have in all cases driven pile foundation. We find it cheaper to drive piling than to have a stone foundation from the fact that stone is liable to shatter. We drive 21 piling under each scale, using timber of course for the superstructure.

Mr. Peck.—My experience is that concrete foundation for scales is better than either stone or piling. The advantage of concrete foundation is that when you dig a trench you can fill it in very readily, and there is no possibility of water coming through, while with a stone foundation this is not the case. It is true it requires some time for concrete foundation to set and get strong; where we build stone-work and want a good foundation, we almost always place concrete under it.

Mr. Markley.—I do not know why that portion of the committee that made the minority report should condemn the use of stone. In some sections they can get stone; in others it is not to be had. I have put in a number of scale foundations and have used stone and brick, and in one instance drove 40 ft. piles with grillage. I have built quite a number of scale foundations of rubble work; they are good to this day. As far as condemning stone, I think it is the most economical where it can be obtained in suitable sizes. The Cincinnati Southern put in a large track scale with very large stone. They concluded to remodel the yard, which necessitated moving the scales. They took a derrick car and moved the foundation, except the pit, which they filled up. If a stone foundation is put in substantially and solidly it will certainly last well.

Mr. McNab.—In soggy ground, where you have to drive piles to get a foundation, 25 to 40 ft., concrete will not do. Everything depends on the soil.

Mr. Peck.—No matter how soft the material, if piling will hold, concrete will also hold, and the solidity of the foundation depends upon the size and thickness of the walls. Where the foundation is very soft, the area of the walls should be increased, so as to secure the necessary strength to prevent them from going down, or straining.

Mr. Markley.—Of course concrete is used very largely in place of timber foundations. Have put some in at $2.35 per yard,—the cheapest it was ever done; masonry, $4.50 per yard. An 85 cubic yard job cost us $175.00 for the stone.

Mr. Mallard.—We drive piles here, the whole ground is thoroughly saturated, sometimes at a depth of 18 in. it is almost a lake. In lots of places where the piles are too short the buildings have gone down; 30 ft. piles will not carry, and in all new buildings 50 ft. piles are being used. The custom-house in New Orleans is a sample; it was put in on mud-sills and one end has gone down about 20 in. more than the other. I think the foundation should depend upon the locality in which it is put in. If you have a wet country, soft soil, you certainly have to use piles.

Mr. White.—I have never used concrete for scale foundations, but I like it from the simple fact that I have put in quite a lot of machinery in railroad machine shops, such as shears and heavy machinery. In very soft bottom where I can get sufficient surface

of gravel, I use 4x12 or 6x12. We have some foundations that have been in for fifteen, sixteen, eighteen, and twenty years, and the master mechanic informs me that they have never stirred; just as level as when they were put in. I do not see why concrete would not be very good for scale foundations as well as for machinery, as it stands the vibration.

Mr. Damon.—I have put in scales in Tennessee and in Maine. In one instance I used piling, and in the other concrete. In Arkansas, in one instance I used piling, and in the other concrete; in Maine I did not use piling; used timber foundation. I think in all cases you have to adapt yourself to the situation; whether it requires a pile 5 ft. long or 25 ft.

Mr. Mallard.—I would like to ask Mr. White if any of these foundations were in Texas?

Mr. White.—Yes, sir. Part of this work that I put in twenty-two or twenty-three years ago was in very soft ground; not more than half the length of the machine shop from there it was hard. I used a very wide foundation for concrete in one case; in the other did not use anything at all. In Texarkana, I drove piling, a cluster of piles, then used concrete as Mr. Peck speaks of. For turn-table pits and walls, I drive piling, fill the intervening space with concrete, cut off the piles, and fill right up to the top.

Mr. Markley.—Was there not some danger of the piles rotting?

Mr. White.—No, sir; the piles are completely covered with concrete. We all know it is at the surface of the ground that the pile rots,—as the seamen say, between wind and water. We invariably cut our piles off below the surface. Have never known piles to rot when cut off this way and covered with concrete.

Mr. Mallard.—It depends a great deal on the character of the country you have to deal with; if you go out in this arid country, where the soil is dry, the piling would rot in the ground.

Mr. Kelleher.—I have had a great many scale foundations; and it is all owing to the nature of the soil as to what you use. I have often laid them in brick, and found no settlement whatever. It is entirely owing to the nature of the soil.

Mr. Hanks.—I consider a stone foundation, if properly constructed, covered with Portland cement and properly drained, is the best. I would like to say for the information of the members that the F. & P. M. road have a scale tester, they keep it in a car

with the weights; with this car they can raise the scales two feet and a half very readily, and with the use of blocks this will allow you to take your scales apart, clean them up, brush them off, and, if you please, paint them, and lower them again. It saves a great deal of expense, by having a test car that we can ship from one point on the road to another; let the weigh master test the scales and report the weights to the tester. The tester does not have to go with the car, unless work is necessary.

Mr. McNab.—This summer we have built four scale foundations; three of them were built out of rather soft stone, sand-stone, and the other out of hard-heads. Up in our country, in the spring of the year, the sun melting the snow and it freezing again at night, affects the stone, not at the bottom, but at the top, causing it to crumble. We have been getting hard stone for all scale foundations that we have put in for the past four years. In fact, none of these scales have lasted four years. In putting them in, I think the climate, weather, and the material that you use have a deal to do with the kind of foundation.

Mr. Austin.—I think you should adapt yourself to the soil. I put in a scale eight years ago, driving piling. Where the stone is either Rockport or Quincy granite, which freezing does not seem to hurt, it makes a good foundation; in soft material, I drive piling, cutting them off about four feet from the surface, where the salt water strikes them, through marshy, murky stuff, then use granite and top off with hard-burned brick. Some put in there eight years ago have never had anything done on them.

Reading of report of auditing committee.

AUDITING COMMITTEE REPORT.

NEW ORLEANS, LA., October 15, 1895.

To the President and Members of the American International Association of Superintendents of Bridges and Buildings:

The auditing committee would respectfully report that they have carefully examined the books and vouchers of the secretary and treasurer and find the same correct.

Received for dues	$144.00
First assessment	6.00
Second assessment	55.00

New membership	$95.00	
Received for advertisements	285.50	$585.50
Credited by voucher		$585.50

J. M. STATEN.
G. W. HINMAN.
J. H. MARKLEY.

Report received and committee discharged.

WEDNESDAY MORNING SESSION, OCTOBER 16, 1895.

Mr. Andrews.—Report No. 10,—"Interlocking Signals." We have heard nothing as yet from Mr. Travis, and the only member of that committee present is Mr. Heflin. The question before you is whether the committee should be continued, or the subject passed by.

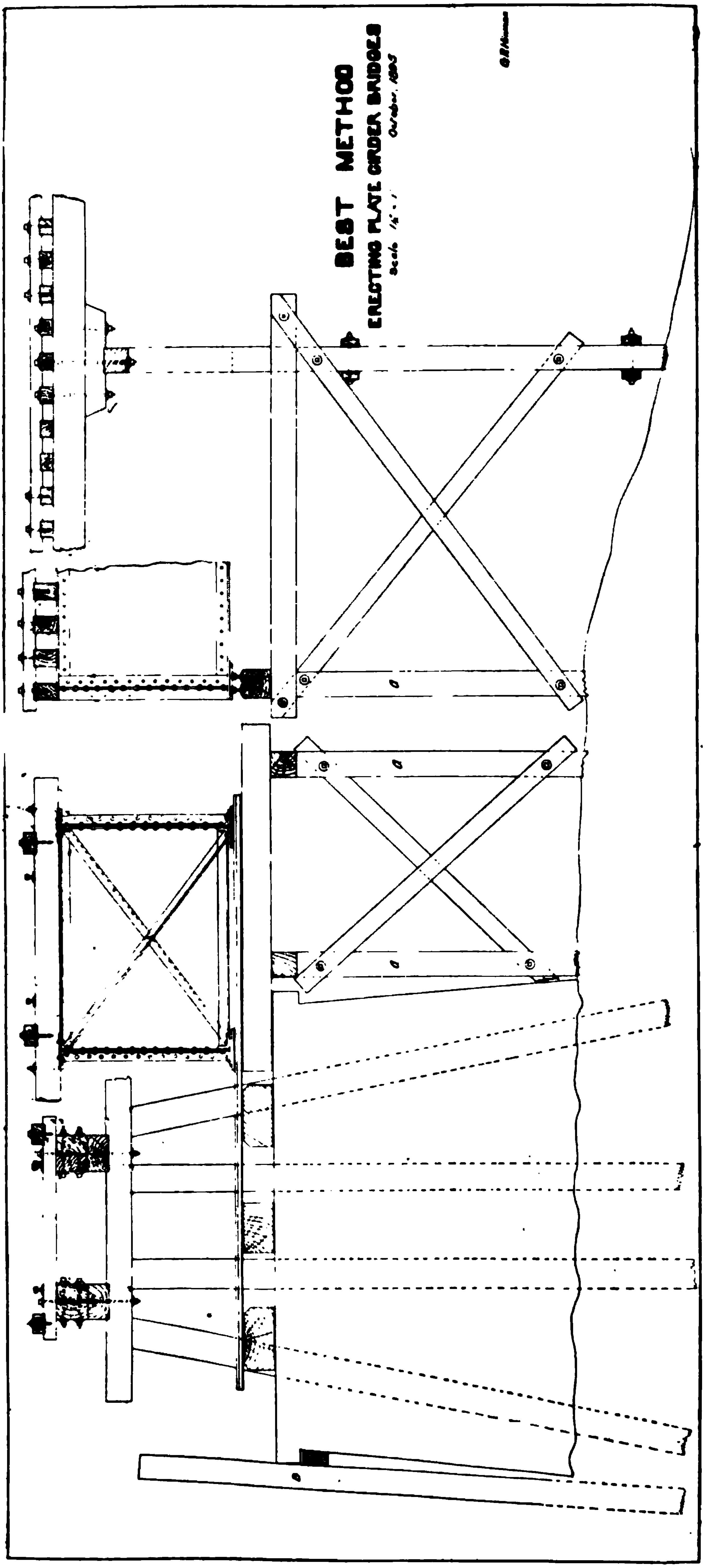
Moved and seconded that the subject be passed. Carried.

Mr. Andrews.—The next subject is that which was laid on the table yesterday. Mr. Hall's amendment to Article IX, Section 1, by striking out the words "two dollars," and inserting the words "three dollars," for annual dues.

Mr. Shane.—I am disposed to make a motion on the subject, but do not like to do so, until I am a little better informed. I would like to have from our secretary a statement of the annual disbursements, our finances and our income.

Discussion of Subject No. 2,—"Methods and Special Appliances for Building Temporary Trestles Over Wash-outs and Burn-outs."

Mr. Shane.—It seems to me that it does not matter which plan is adopted. The article which we have had read is a very good one; as far as the question of erection of temporary structures is concerned, it depends entirely on the environments and the judgment of the man having the work in charge. It seems to me that no settled rules or methods could be laid down that could be adopted. They might do in one instance, and in another it might be necessary to use something altogether different. I see but very little chance of discussing this question at all. If any member reading the recommendations of the committee sees anything he might adopt at any time, he has the opportunity of taking advantage of it.


BEST METHOD
ERECTING PLATE GIRDER BRIDGES
Scale 1/8" = 1'
October, 1895

No. 4,—"Best Method of Erecting Plate Girder Bridges." Report read by Mr. Hinman.

EVANSVILLE, Ind., October, 1895.

To the President and Members of the American International Association of Railway Superintendents of Bridges and Buildings.

Being a member of your committee on the best method of erecting plate girder bridges, and not being able to meet with the committee, I hand you a plan of what I consider one of the best methods of erecting plate girder bridges.

First, erect false work (A) at each end of the span, placing the top of it on a level with the top of the pedestal rock, on the piers, then place two railroad bars of track iron on top of the false work (A) at each end, and let them run across the false work and pedestal rock. Then lower your girders down onto these railroad bars and place your girders in the same position they should be when in the bridge, and put in your struts and lateral bracing, rivet them up, and put on your ties and guard-rail, and finish up the span complete. When this is done, remove the old bridge, and shove the new bridge into place. This is very easily done when the railroad bars are well oiled, and you will find that the girders move very easily.

Note the post (B) placed at the opposite end of the pier. Build a platform near this post, to set your winch on, then make your tackle fast to the post and the girder, and pull your girder into place.

This is for girders sixty feet long and upwards. Girders from thirty to fifty feet may be pinched into place with pinch bars.

The best method to unload the girders from the cars is to put up a timber bent at each end of the bridge, and use a winch and tackle to lift the girders off the cars and lower them down onto the false work. Should you have two wrecking cars handy, you can use them to unload the girders with, but the timber bent is the cheapest, and usually the safest.

Respectfully submitted,
G. W. HINMAN,
Sup't L. & N. R. R.

No. 5,—"Best and Most Economical Railway Track Pile Driver." Reported progress and were granted more time.

No. 6,—"Sand Dryers, Elevators, and Methods of Supplying Sand to Engines, Including Buildings."

Mr. Aaron S. Markley.—If there is any gentleman here who has a steam sand dryer in operation, I would like to hear from him.

Mr. Shane.—Unfortunately, this subject, I think, does not interest us as much as a whole as perhaps a few individuals. Perhaps a large majority of our members have nothing to do with sand dryers, except to erect them. Now, on our system we erect them, and once the building is in position, we have nothing whatever to do with it. The motive power department maintain

it and it is immaterial to us how it operates, whether it is successful, economical, or not; it is erected and off our hands. I believe this is the case with the majority of the gentlemen; there may be a few who have to maintain them.

Mr. Markley.—The drying of the sand is for the company by which we are employed, and if we can get any good ideas by which we can help our master mechanics, it is our duty, as we are all working for the same company, and the money that pays us comes from the same pocket. While I have not myself anything to do with the construction, I have been called on by our motive department for ideas as to what would be the best arrangement at our principal points, and I suppose other members will be asked the same question.

Mr. Millener.—I have seen a great many sand dryers, but nothing that would compare with those we have on the B. & O. road at Washington, Ind., designed by Mr. Hall. The building is of brick, immediately at the end of our coal chute incline. At the end of it we have a large shed to store the sand before it is dried. We fill this shed in the fall of the year, by hauling sand and throwing it in. The intention at first was to run the sand into dump cars and dump it from them into the shed. The sand is put into this brick building and dried in a large stove, which is made with a hopper of sheet-iron and wire. The sand is dried in there thoroughly and then run into two bins with hopper shaped bottoms. The sand is run into a chute operated by the upper gearing of the elevator, into hopper bottom bins, from which it is run into engines,—by a 4 in. sand spout, similar to those used in a water tank. One man does all the work of elevating the sand; the fireman, when the engine takes sand, moving the lever and letting it into the dome. We have blue prints of it, which Mr. Hall intended to send to this meeting; for some reason he overlooked it.

Mr. Eggleston.—We have here a few blue prints that I sent here of what is used on the Erie System, which I would like the gentlemen to look at. I do not see where they can be improved on much more and the cost of handling sand reduced.

Mr. Heflin.—For the information of the members of the association, I can only give a little experience. I have three or four houses on my line in which we dry sand. While they are made of different material, some of brick, others of wood, they are all con-

structed upon the same principle. We have a bin about 18 ft. wide, 36 ft. long; at the end are a couple of rooms for storage of the wet sand. In the center room we have a coil of steam pipe; at the other end is a room for dry sand. The sand is thrown first into the room for storage, then shovelled on to the steam pipes, then when dry it is shovelled through a screen which is erected across the building, then shovelled into the room for dry sand. The fireman runs the engine up beside the building, conveying the sand to the sand-box by buckets. All our new sand houses are arranged in this way. We have been looking for some means by which we might handle the sand from the sand house to the engine in a better way, for instance, a spout as was mentioned.

Mr. Kelleher.—I would like to ask the gentleman if the sand drying process is under his charge.

Mr. Heflin.—No, sir; I construct the building, the motive power department dries the sand.

Mr. Kelleher.—I think the remarks of Mr. Shane were very pertinent, and that when we have erected these buildings our part of the work is done.

Mr. Millener.—Let me state for the information of the gentlemen one thing which Mr. Heflin has not stated. Mr. Heflin and I have the honor of being connected with the same company; we have to build, and maintain the sand dryers; the machinery department dries the sand.

Mr. Eggleston.—For the benefit of the gentlemen who last spoke, if they will examine the Erie blue prints they will find a very good system of conveying sand from the house to the engine through conveyor.

Mr. Wallace.—I would like to ask a question of the gentleman in regard to this drying of sand, whether these buildings are constructed by the methods of the bridge and building department, or the chief engineer's department, and the drying process is suggested by the B. and B. department, or if we of the B. and B. department are taking items from other departments, which we admit we are taking from our department of other roads. But the question is this: now if we erect a sand dryer, we arrange the elevating of it and other portion of it; that would belong to the B. and B. department, provided it is included in this work. It seems to me as Mr. Shane has said, that it is a thing that concerns very few of us.

Very probably we are furnished with a plan of these buildings to erect same as a depot; possibly we are asked as to the best handling of it; we know but very little about it, and I think the percentage of the members of this association concerned in this sand drying business would not amount to two per cent.

Mr. White.—I have no recollection in all my experience of but once having to invent or erect a sand dryer on my own responsibility. I do not mean the building but the dryer; then it was new work. There was no machinery department there and the whole responsibility was left to me. I erected just a common sand dryer, using one end of the building for wet sand, the stove in the middle, simply made of boiler iron, and the screen before the dried sand at the other end. It seemed to answer the purpose very well, but I paid no attention to it after it was built; merely did this as an accommodation.

Mr. Peck.—We use the Plock sand drying stove on the Mo. Pac., and I believe it does very well. They have made some improvements on the stove in the last few years. We usually dry our sand at the most convenient point to secure it. We elevate the sand at our coal chute, shoveling into a bin, the same as we shovel our coal into coal-bins,—elevated sufficiently to enable the engineers and firemen when they run on to the coal chute to take sand at the same time, or immediately after or before with coal, without unnecessary detention. The spout is raised so it reaches the sand dome of the engine the same as water-spouts reach the tank,—delivered into the spout by a valve, so that it makes a very quick method of delivering sand. We have experimented considerably with different methods, but have not found anything that was very satisfactory; in fact we have come to the conclusion that this sand drying stove is the best method. I think the stove should be entirely of cast-iron,—sheet-iron is too easily warped with heat and causes extraordinary expenses on account of repairs. Even the pipes should be cast; at least for some considerable distance from the stove.

Mr. Wallace.—I would like to ask Mr. Peck if he furnishes this stove to the B. and B. department, also the cost of them; and if he gets reports from them, whether they come under his special supervision or not.

Mr. Peck.—I have charge of the erection; the sand drying is under our master mechanics.

Mr. Stannard.—Our method is the same as Mr. Peck's.

Mr. Mallard offered one of the Southern Pacific tugs for a trip on the river, and stated that the New Orleans Traction Company had very kindly offered a trip over their lines, but owing to the dust the offer had been declined and this trip gotten up instead.

Mr. Kelleher made a motion that the invitation of the Southern Pacific be accepted, provided it does not interfere with the proceedings. Seconded.

Mr. Berg.—I think we all appreciate the kind offer of the Southern Pacific Railway made through Mr. Mallard, and would like to accept it. I think, however, the association should not actually accept the invitation to go as a body, as we would have to give up the business of our convention this afternoon. We are already under obligations to the Southern Pacific for the trip extended to us to-morrow, which I think we will take, and unless we close up the business of the convention to-day, we cannot do this; with a proper afternoon session, I think the members who have business or who wish to go away can get away to-night, and those who wish can go on the excursion to-morrow. I think that we had better stay at work this afternoon and finish the business of the convention. Therefore, I move as an amendment to the motion made by Mr. Kelleher that we accept the invitation, but owing to the business of the convention in hand we cannot attend as a body.

After further discussion it was voted not to accept the invitation in a body.

Mr. Hall's amendment to the constitution, Article IX, Section 1, to strike out the words "two dollars," and insert "three dollars" before annual dues. After reading of statement of finances by the secretary, Mr. ———, seconded by Mr. Markley, moved that the amendment be adopted.

Motion carried unanimously.

No. 3. Strength of various kinds of timber used in trestles and bridges, especially with reference to southern yellow pine, white pine, fir, and oak.

Mr. Cummin.—It seems to me that from the nature of the com-

mittee's report on this subject, discussion had better be postponed until the next annual meeting, because I fail to see how the members can discuss the question intelligently until the report of that committee is printed in full.

Mr. Kelleher.—I fully agree with Mr. Cummin that the report made by Mr. Berg is elaborate and requires study, and I think should be understood by the members before they discuss it. I wish to say in addition, I have here in the room fifty-three specimens of timber that I would be glad to have the members inspect, —long leaf yellow pine and creosoted, some of which has been twelve years in service. I have also some specimens of white cedar obtained from a tree 60 ft. in length; the top and butt are there for the inspection of the members.

Mr. Peck.—I would like to ask Mr. Berg for the comparative safe strain of white pine and fir.

Mr. Berg.—The comparative ultimate breaking strain of white pine and fir: in tension, 7,000 lbs.; Douglass yellow fir, 12,000 lbs. In compression with grain white pine, 5,500 lbs.; Douglass yellow fir, 8,000 lbs. Transverse rupture, extreme fiber stress, white pine 4,000 lbs., Douglass yellow fir 6,500 lbs.; white oak 6,000 lbs. Shearing with grain, white pine 400 lbs., Douglass yellow fir 600 lbs.; white oak, 800 lbs. White oak in tension with grain, 10,000 lbs.; white oak compression with grain, 7,000 lbs.

No. 4.—"Best method of erecting plate girder bridges"; report from Mr. Hinman, and appendix from Mr. Staten.

Mr. Eggleston.—I have had considerable of that kind of work to do since 1890; we take our girders anywhere from 17 to 45 feet in length, set them to one side on temporary bents, rivet them and put the floor system in complete, and then get the use of the track, pulling them in in forty to fifty minutes, may be an hour and a half, according to the length of the bridge. We have put in some 82 ft. through girders in almost the same way; have them unloaded and fitted up alongside, take out your girder and shove them over. I have never had a bridge yet that took more than an hour and thirty-five minutes to put in, 82 ft. girders.

Mr. Reid.—About a year ago I had two girders to put in, 33 ft. 10 in. long; put in the girder on the south track first; riveted the girders altogether, hitched the engine on to the girders and pulled

them right up just where we wanted them, took out the false work and let it right down on the masonry; had no trouble. One of these girders I hauled a mile, doing the work the same day,—held the track one hour and thirty minutes. I put in girders 82 ft. 6 in., had them all riveted up and hauled them out; had no trouble of any kind.

No. 8.—"Best method of spanning openings too large for box culverts and in embankments too low for arch culverts."

Mr. Stannard.—I would like to hear from Mr. Peck.

Mr. Peck.—I do not know that I have anything to say that would be of interest to the members of the association, but would state that our method of bridging such openings is to build stone walls with necessary foundations of stone or concrete, raise the walls to proper height and use old rail, discarded rails from the track; span the openings, placing the rails from eight to twelve inches apart, according to the width of the opening. The space intervening is filled in with concrete, after being planked. We use concrete walls on the side, level up with the base of rail, fill, and after leveling off pack with cinders to a depth of eighteen or twenty inches, and place our ties the same as on ordinary roadbed.

Mr. Aaron S. Markley.—Would not that make a place to retain the water, or do you provide for draining the water?

Mr. Peck.—In answer to that would say that our retaining walls are not solid at the end,—there is plenty of room to admit of the water passing out. We use three parts of sand to one of cement; very often use American cement.

Mr. Middaugh.—I would like to ask Mr. Peck if he has tried large iron pipe in cases of this kind, and how it would compare in cost with the plan he speaks of. Seems to me it would probably be very much cheaper.

Mr. Peck.—We usually use this plan where pipe is not practicable in openings from six to twelve feet. Four foot pipe is as large as we ever think of using, and where that will not do we have a great many openings where two pipes are used, but it is troublesome on account of debris filling them up and blocking the waterways; and find it important to leave all the opening possible on account of the liability of corn stalks and other debris stopping the passage of the water.

Mr. Eggleston.—Why not double two old 12 inch eye-beams on masonry and put your floor system on that?

Mr. Peck.—We frequently use eye-beams because we most always have some that can be got without trouble. We use them where we would otherwise use old rail.

Mr. Eggleston.—Do you truss this rail any?

Mr. Peck.—Not at all.

Mr. White.—All this talk that I have heard strikes me as being applicable to old established roads. I would like to get some views on new work. I am unfortunately connected with new work. We cannot use old rail for the simple fact that we are just starting new. I would like to get the ideas of some of the members in regard to temporary openings for new roads, three, four, or five years, and would be very much obliged for the information.

Mr. Mallard.—The Southern Pacific use a system, I think, somewhere near El Paso, where they have irrigation ditches; water very nearly up to the rail; they use channel iron about twelve inches, riveted up, and on the top place a six by twelve, to which the rail is spiked. I am not prepared to give the cost of this.

Mr. Eggleston.—On permanent work and through girders there is a floor system that is made for the purpose. You can get your rail within 12 inches of the base of your bridge for permanent work.

Mr. Markley.—You refer to the Buckle bridge, do you not?

Mr. Eggleston.—Yes, sir.

Mr. Markley.—I would like to ask Mr. Eggleston what he uses on the Erie where there is not room enough for iron pipe.

Mr. Eggleston.—When we cannot put in iron pipe, we use a through or deck girder or truss bridge. We can put in three foot pipe without danger of its becoming stopped up with wood and debris because we keep our right of way clean.

Mr. Markley.—We keep our right of way clean, but it comes from the woods.

Mr. Berg.—In answer to the question of Mr. White, what to do in new work, temporary new work, four or five years, I should say use any kind of trestle, if properly constructed, and I believe this is what you might call standard practice. It allows the work to be rushed forward to complete the railroad and then whenever you find the finances allow, masonry and iron construction can be built much cheaper on account of the facility with which material can be

brought to the site of the culvert. In regard to the use of the old rails spoken of, I am an advocate of their use in a simple form, by which I mean when used without too much shop work to be done on them, and without elaborate castings and yokes.

Mr. White.—For small openings that we have, what is the most economical.

Mr. Eggleston.—I like Mr. Mallard's idea of using channel iron.

Mr. White.—The information I want is where we have no channel iron; we have no such thing as old rails.

Mr. Staten.—I would recommend making a box, where he uses good timber and cross-ties, and put them in wherever he can use them; this will last several years. These boxes you can have made and unloaded and set in the track wherever you prefer.

Mr. Berg.—I think Mr. Staten in speaking of box culverts is getting off the subject. I think that trestles are the proper form for temporary construction; you can make your span wider than is required so that when the time comes for permanent work, it can be built right in. That is where another advantage of the trestle comes in. You can use channel iron or regular floor system.

Mr. Millener.—We are building a little piece of new work at the present time, where the fill ranges from six inches to eight or ten feet. We are using in these wide places pieces of old floor beams or stringers that came out of other bridges. We have taken a great many old iron bridges out and have a good many of the eye-beams from nine to fifteen inches in width, which we are utilizing for these wide openings.

Mr. Peck.—For the benefit of Mr. White would state that our standard box culvert is built with wooden walls and covered with a big flat stone.

Mr. Berg.—I would like to ask Mr. White what the covering is of the box culvert he refers to.

Mr. White.—We make our box culverts for twelve feet openings of old stringers. As a little information for the members, would say that in this southern country, Mr. Peck and the balance of us in Texas and Missouri, use the slabs of Bodak, which will last forever. We cover over the stringers with these shavings and then a covering of dirt, and have no further trouble with it.

Mr. Berg.—Then I understand, Mr. White, where you have an opening too large for a single box culvert, such as is generally under-

stood to be covered over with stone, and too low for arched culvert, that you adopt a system of double, triple, or quadruple timber boxes.

Mr. White.—That is the idea.

Mr. Stannard.—How do you take care of your drift wood?

Mr. Eggleston.—My idea of this is to get in your masonry, steel girders, make it permanent, and your management will never regret it.

Mr. White.—Different points in the country have different usages. We have to use timber for the simple fact that we have not the rock; you have to use rock, perhaps, because you have not the timber. Another thing, our management will not go to the expense of getting us rock or girders; all this comes after we are an old established road. I am working for a new road where these things can not be afforded.

Mr. Eggleston.—We have wood in the north, but do not use it; wooden bridges have to be renewed every five to ten years, while iron and masonry will last forever.

Mr. Millener.—Stone is a scarce article with us, but we have lots of cedar. Where we have low culverts and additional openings are necessary, we simply make double or triple culverts,—that is, where we cannot bridge over. We put in a course of timber, one on top of the other, and make the openings wide enough and a number of them.

Mr. Eggleston.—The condition of your roadbed and bridges is an advertisement of any system. The best of your people will ride on the hind end of the sleeper, and if they see poor structures will make comments. If you have first class bridges and maintain them all the way through, it will advertise your road all over America.

Mr. Berg.—I agree with Mr. Eggleston as to the value of first class structures, but think that a good roadbed throughout, a solid road, is more desirable, if you can have it in place of bridges. On any road a solid roadbed without bridges is certainly preferable to bridges. This being so, I think that in our discussion we have lost sight of the practical value of the structure recommended by the committee, viz., continuity of roadbed; another advantage is in having ordinary track forces attend to the track at this point, and not having another bridge on your right of way. Of course, it may save the labor for the bridge department, but it certainly is an improvement in railroading.

Mr. Mallard.—On these ballast openings, we have a depth of only 25 inches, track tie 7 inches, use 8 inches of gravel, and 13 pieces creosoted 10x12, laid on piles for 16 foot openings.

Mr. Berg.—Another advantage of the solid, continuous roadbed, as shown in the plan recommended by the committee, or similar to that plan, is that you avoid the jump that invariably takes place in going on to regular track off a trestle, which point Mr. Mallard brought out yesterday as one of the advantages of the solid deck being adopted in this section of the country.

Mr. Eggleston.—I would like to ask Mr. Mallard where he does away with the jerk on marshy ground; if you put a solid roadbed on the trestle, where are you going to relieve the shock right at the end of the trestle?

Mr. Mallard.—We do not get any shock; I can better explain to you tomorrow after you see it; we do not have any shock; we have eight or ten inches of gravel under the ties; continuous roadbed running off the trestle.

Mr. Berg.—Taking the words of Mr. White, I think that the shock is removed by the under layer of ballast, which amounts to a cushion, and while that cushion does not have the earth underneath it, but solid timber, the ballast still acts as a cushion, and relieves the shock to some extent; there is also more mass opposed to the shock, which reduces the effect of the blow.

No. 11.—"Pumps and Boilers."

Mr. Eggleston.—I would like to have this brought out in full; we expect to put in considerable of this kind of work in the near future.

Mr. Aaron S. Markley.—On our line we use nothing but Worthington Duplex pumps, 7 inch suction, 6 inch discharge; while we have a lot of other pumps, they have been left over from long ago. The size is 8x12x12, manufactured by Fairbanks, Morse & Co.; the manufacturers have their own number, consequently the size of the pump can only be given by the dimensions. We connect all of our exhaust pipes into the suction pipes, thereby, of course, preventing freezing in winter time. In making this connection, we use a cast-iron "Y," sufficiently large of course to receive the exhaust pipe. This is located 16 feet from the pipes; we have tried them closer, but it will suck air, and cause the pump to jerk. In connection with this, we now use a second discharge pipe, in case we want to

turn it out direct, either in the stack, or the roof of the building. The dimensions of our pumps are: Surface, 8 inch water end, 10 inch steam end, 12 inch stroke, 7 inch suction pipe, 6 inch discharge, with a capacity of 18,000 to 20,000 gallons an hour; Cook, 8 inch steam cylinder, 36 inch stroke, 5¾ inch working barrel; Downey double acting pump, 8 inch steam end, 24 inch stroke, 4¾ inch water valve. A description of our building is submitted by the committee on this subject.

Mr. Millener.—I would like to ask if any of the members are using compressed air for pumping water. Our management has bought an air compressor, but I have never used one of them myself, and do not know of anyone that does. I understand that the air compressor is three fourths of a mile from the well, air is taken down into the well in a two inch pipe, and the water is forced back through a three or four inch pipe.

Mr. Berg.—As there are just fifteen members in the room, and fifteen make a quorum, I move that we adjourn the discussion until two o'clock. Carried.

AFTERNOON SESSION.—WEDNESDAY, OCT. 16, 1895.

Mr. Andrews.—No. 11, Pumps and Boilers,—one of the gentlemen asked this morning relative to air compressors used in this connection.

Mr. Heflin.—We recently put in one on my division, it was manufactured by a man by name of Reef, of Roanoke; has been in five months and has given entire satisfaction; put in at a station that had formerly been furnished with water by a pump; since we put it in have had no trouble. In a 12 foot fall, we have raised water about fifty feet. They are the best thing, where you can get the fall, that I ever saw, for the work. The pump, or ram rather, will lift the water thirty feet for every foot of fall that it has to drive pipe. In those that we use the drive pipe is four inches, discharge pipe to tub is two inches. Will state in connection with this that about one sixth of the water that is used to run the ram is conveyed to the tub, the other by oscillation and re-action, five sixths, is lost. The expense of keeping them in repairs is, so far as I can learn, very little; these people guarantee to keep them in repair for

five dollars a year. The only repairs necessary are a valve in the cylinder air chamber. As to pumps, have a variety, Knowles, small Erie, Blake, Cameron, but the pump that gives the most satisfaction is the special No. 9 Blake pump, which I am using altogether in ordering new pumps. The others have been in service a number of years, have been taking out three or four a year; have thirty-nine water stations, at most of which I have two pumps. The boilers we use are from twenty-three to forty-eight inches diameter, outside measurement, twenty-three, twenty-six, and thirty-six inch grate bars. Some of these boilers have submerged flues, others not. The thirty-six inch boilers have twenty-three inch grates, and, ordinarily, will run one of our No. 9 pumps without any strain of the boiler; but the new boilers that we get, for emergency, in future, are forty-six or forty-eight inch boilers, that will run two No. 9 pumps very nicely if we do not have too much lift; and this is a thing that we do not have a great deal of, except in two places, where we have a great deal, nearly the capacity of the pump, thirty-three feet.

Mr. Markley.—Mr. Heflin says that five sixths of the water is lost; do I understand that it is gone entirely, or is it returned to the tank?

Mr. Heflin.—No, sir, it is not; if you can raise a dam, say six feet, you can carry the water 180 feet, a certain quantity; you lose five sixths of the water from which you gain your power.

Miscellaneous business.

The following resolution was offered by Mr. Berg, and adopted:

Whereas a most comprehensive and valuable series of investigations into the properties of wood and tests of the strength of our commercial timbers have been carried on in the Division of Forestry of the United States Department of Agriculture;

Whereas these investigations have already demonstrated that a most decided improvement in the practice with timber structures and use of wood and a saving of millions of dollars worth of wood material are attainable as a result of these investigations;

Be it Resolved, That we, the Association of Railway Superintendents of Bridges and Buildings, assembled in regular session, at our Fifth Annual Convention at New Orleans, La., October 15, 1895, endorse, as railroad officials in charge of the construction and maintenance of timber structures and buildings of railroads throughout the United States, the work thus inaugurated by the United States government as tending towards a most needful and rational economy of our forest resources and desirable improvements in their use, resulting not only in a great saving to users of timber throughout the

country, but especially offering a valuable guarantee for the absolute safety of properly designed timber structures;

Resolved, Further, that we ask our representatives in congress to make liberal appropriations for the continuance and more rapid advance of this work, in order to secure, as quickly as possible, the much needed information, believing that the government alone is in a position to secure it and that it is true economy to provide it without delay;

Resolved, Further, that these resolutions be transmitted to the president of the senate, the speaker of the house of representatives, the secretary of agriculture, the chairman of the committee on agriculture of the senate, and the chairman of the committee on agriculture of the house of representatives.

Resolution read by the secretary extending thanks of the association to the various railroads, press, etc., adopted.

Resolved, That the thanks of this association be tendered to the Southern Pacific Railway Company, the Queen and Crescent Railway Company, the Louisiana Sugar and Rice Exchange, the New Orleans Board of Trade, and the New Orleans Cotton Exchange, the Pullman Palace Car Company, and the management of the Hotel Grunewald, for courtesies extended the association.

The following resolutions were read and unanimously adopted:

Resolved, That the secretary convey the thanks of the association to Messrs. E. H. R. Green and J. L. White, and the Bridge and Building Department of the Texas Midland Railway for the handsome banner presented to the association.

Resolved, that the secretary convey the thanks of the association to the Shermin-Williams Company for the handsome souvenir badges presented to the members.

Resolved, That the thanks of this association be tendered to Mr. James Stannard, chairman of the executive committee, for his services in securing accommodations, and making preparations for this meeting, and also to Messrs. Charles C. Mallard and T. H. Kelleher, the resident members forming the local committee, for their kind efforts in providing for the hospitable reception and facilities accorded the association and its members during the meeting.

Resolved, That the association desires to thank the officers for their attention and efficient conduct of the business of the association during the past year and especially to express its warm appreciation of the prompt and courteous manner in which the outgoing president, Mr. George W. Andrews, has guided the business of the association during the present convention, as also the careful and painstaking work of our secretary, Mr. S. F. Patterson, in the routine work of his office and more particularly in the arduous task of supervising the publication of the proceedings of the last convention.

Resolved, That this association desires to express its appreciation and thanks to all non-members of the association who have rendered valuable assistance to the various committees in the preparation of their reports; and that the secretary be directed to transmit these resolutions, together with a complimentary copy of the printed proceedings, to all such parties as specified by the chairmen of the several committees.

Resolved, That the association desires to thank the representatives of the technical and local press for their attendance at the convention.

Resolved, That the chairmen of all committees on subjects for investigation be required to present their reports to the secretary not less than one month prior to the holding of the annual convention, and that the secretary be directed to have printed copies of said reports prepared and ready for distribution to the members and the technical press on the first day of the convention.

Mr. President.—Under the head of miscellaneous business, I would like to say a few words in regard to one of our members. I allude to Mr. John Foreman of the Philadelphia & Reading R. R. Since our last meeting at Kansas City, two events have happened in his life which I doubt can be duplicated in the life of any railroad employee in this country. Last January he celebrated the fiftieth anniversary of his continuous connection with the Philadelphia & Reading R. R., and last week he celebrated his golden wedding. It seems to me that an event of this kind should not be allowed to pass unnoticed by this association, and I therefore move that our secretary be instructed to write a suitable letter to our worthy and aged Brother and his wife congratulating them upon the long and happy life they have spent together, and expressing the hope of the members of this association, that they may enjoy many more years of wedded bliss together, and that at our next meeting we shall not only have the pleasure of greeting our worthy brother, but also his estimable wife.

Motion seconded by Mr. Eggleston, and unanimously adopted.

Mr. Andrews.—Under the head of miscellaneous business, I wish to call the attention of all members to the subjects that will come up for discussion at the next meeting; in doing this, I desire to get some information for the gentleman who will be our next president, and who I am sure will make a most excellent one. He, unfortunately, has not been able to be with us at this time, and I desire to get as much information as is possible in the formation of his committees. We are, however, only recommending those who are interested deeply in particular subjects, and I desire to know who are so interested in the various subjects that we may give him this information to assist in the formation of his committees intelligently, and with justice not only to the members, but the benefit of the association in general. I hope no individual members will have any delicacy in stating which of the subjects they are particularly interested in.

Committees appointed by the President on the subjects for report as follows:

No. 1. How to determine the size and capacity of openings for water ways: Aaron S. Markley, J. S. Berry, C. C. Mallard, J. L. White.

No. 2. Different methods of numbering bridges: A. Shane, W. O. Eggleston, J. L. Soisson, O. J. Travis.

No. 3. Draw-bridge ends, methods of locking, and under this head including locking of turn-tables: H. M. Hall, James Stannard, H. Middaugh, C. C. Mallard.

No. 4. Protection of trestles from fire, including methods of construction: R. M. Peck, T. H. Kelleher, A. McNab, W. M. Noon, G. W. Hinman, William Berry.

No. 5. Local stations at small towns and villages, giving plans of buildings and platforms: J. H. Cummin, N. M. Markley, J. H. Markley, C. G. Worden.

No. 6. Tanks, including frost proofing, size, style, and details of construction: W. O. Eggleston, W. M. Noon, A. McNab, N. W. Thompson.

No. 7. Shearing of rivets on plate girders and cause thereof: J. M. Staten, R. L. Heflin, J. H. Travis, G. M. Reid.

No. 8. Best and uniform system of report blanks for bridge and building department: G. J. Bishop, W. O. Eggleston, Onward Bates, M. Riney.

No. 9. Protection of railroad structures and buildings from fire: Charles Parsons, R. M. Peck, L. K. Spafford, B. T. McIver.

On Applications for membership: H. M. Hall, O. & M. R. R.; A. C. Davis, B., S. & T. R. R. R.; R. M. Peck, Mo. Pac.; G. W. Hinman, L. & N. R. R.

Special committee on relief: H. M. Hall, O. & M. R. R.; J. H. Travis, I. C. R. R.; G. M. Reid, L. S. & M. S. R. R.

For selection of city for next meeting, Detroit, Denver, Pittsburgh, Seattle, Wash., Fort Worth, Texas, were placed in nomination and seconded; the president appointed Messrs. Eggleston and Staten tellers, the vote being, Chicago 16, Detroit 5, Denver 3, Pittsburgh 4, Seattle 1.

Mr. Andrews.—Chicago having received the greatest number of votes, I declare that city the place of our next annual meeting.

Mr. White.—I have never learned whether there is a labor committee for the benefit of members who may get out of office; I would like a little information.

Mr. Andrews.—If Mr. White will read the proceedings carefully, he will find a special committee on relief. This committee has made no report. This committee was appointed for affording relief to any member of this organization who at any time is out of a position, and anything that they can hear of they will advise him and endeavor to get him something in the line of his business; the committee will undoubtedly be continued, as it has been for the

past four years. If any member is in need of an assistant, or knows of a road that needs a superintendent of bridges and buildings, he is requested to inform this committee. Last year the committee presented a verbal report; this year I received a letter from Mr. Hall, stating nothing to report, that no business or applications had come before them during the past year.

Mr. Berg.—I desire to call the attention of the members who are not as fortunately situated as I am as regards examining publications of the technical press, that I have been astonished, without endeavoring to hunt for the information, to see such great use made of the publications of this association. I have found references to our publications in all sorts of forms. I have seen whole pages of our reports copied into text-books, giving proper credit to the association. I simply mention this fact so that we can all congratulate ourselves on the extensive use made of our publications. For instance, the article on elevation of track on trestles, was quoted almost verbatim in a text-book, also extracts from the report on water supply, cinder pits, and many others that I do not now recall, but it simply illustrates the value that the outside technical and railroad world is getting from our reports.

Mr. Cummin.—I am glad that Mr. Berg has brought the matter before this meeting, because I think the facts he has stated should be an incentive, not only to the chairman but the members of any committee that will be appointed during the ensuing year on the different subjects, to spur them on and do a little better and more work than they have in the past, if possible.

Mr. Aaron S. Markley.—Another thing, if all the members will forward to the chairman of the committee, without waiting to be asked, information that will aid the committee in its work.

Election of officers:

Mr. Eggleston was delegated to cast the ballot of the association for the following officers elected unanimously:

President—W. A. McGonagle.
First Vice-President—L. K. Spafford.
Second Vice-President—James Stannard.
Third Vice-President—Walter G. Berg.
Fourth Vice-President—Joseph H. Cummin.
Secretary—S. F. Patterson.
Treasurer—George M. Reid.
Messrs. Aaron S. Markley, W. M. Noon, J. M. Staten, members of the Executive Committee.

All the officers, except Mr. McGonagle who was absent, accepted, and were declared elected by President Andrews, who said,—

If the president-elect was here, it would next be in order to conduct him to the chair, and as he is not here, it becomes my pleasant duty to induct the next in line, Mr. L. K. Spafford. This should be done in case anything should occur to our president. I therefore request Mr. J. L. White and Mr. W. M. Noon to conduct Mr. Spafford to the president's chair.

Mr. Andrews.—Mr. Spafford, I want to say to you personally that it affords me great pleasure to see you enter on your new duties, and it will afford me more pleasure next year to see you take the chair permanently for the following year.

Mr. Spafford.—I cannot really agree with you in the matter of taking the place, for fear that I am not thoroughly posted on such matters to do the chair justice; if it is in order I will ask you to continue the proceedings until the close of the meeting.

Mr. Andrews.—I will be glad to give Mr. Spafford any assistance in my power, and if the members have no objection will do the work as suggested.

Moved by Mr. Cummin, and seconded by Mr. Markley, to adjourn until the next annual convention unless sooner called together by the Executive Committee. Carried.

LIST OF ANNUAL CONVENTIONS.

First Convention,	St. Louis, Mo.,	September 25, 1891.
Second Convention,	Cincinnati, Ohio,	October 18, 19, 1892.
Third Convention,	Philadelphia, Penn.,	October 17 to 19, 1893.
Fourth Convention,	Kansas City, Mo.,	October 16, 17, 1894.
Fifth Convention,	New Orleans, La.,	October 15, 16, 1895.

MEMBERSHIP.

Year 1891–2. . . .	Number of active members, 60.
Year 1892–3. . . .	Number of active members, 112.
Year 1893–4. . . .	Number of active members, 128.
Year 1894–5. . . .	Number of active members, 115.
Year 1895–6. . . .	Number of active members, 122.

LIST OF OFFICERS OF THE ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS FROM THE ORGANIZATION OF THE ASSOCIATION TO THE YEAR 1895-'96.

YEAR.	1891-2	1892-3	1893-4	1894-5	1895-6
President	O. J. Travis	H. M. Hall	J. E. Wallace	George W. Andrews	W. A. McGonagle.
First Vice-President	H. M. Hall	J. E. Wallace	Geo. W. Andrews	W. A. McGonagle	L. K. Spafford.
Second Vice-President	J. B. Mitchell	G. W. Hinman	W. A. McGonagle	L. K. Spafford	
Third Vice-President	James Stannard	N. Thompson	L. K. Spafford	James Stannard	
Fourth Vice-President	G. W. Hinman	C. E. Fuller	E. D. Hines	Walter G. Berg	in.
Secretary	C. W. Gooch	S. F. Patterson	S. F. Patterson	S. F. Patterson	
Treasurer	George M. Reid	George M. Reid		George M. Reid	
Executive Members	W. R. Damon	G. W. Andrews		James Stannard	
	G. W. Markley	Joseph M. Staten		James H. Travis	J. L. White.
	W. A. McGonagle			Joseph H. Cummin	A. Shane.
	G. W. McGehee		[illegible]	R. M. Peck	Aaron S. Markley.
	G. W. Turner		James H. Travis	J. L. White	W. M. Noon.
	J. E. Wallace	Aaron S. Markley	Joseph H. Cummin	A. Shane	Joseph M. Staten.

COMMITTEES ON SUBJECTS FOR REPORT AND DISCUSSION SELECTED AT EACH CONVENTION SINCE ORGANIZATION OF THE ASSOCIATION IN 1891.

FIRST CONVENTION, ST. LOUIS, SEPTEMBER 25, 1891.

Subjects.	Committees.
1. Surface Cattle Guards	Aaron S. Markley, J. B. Mitchell, W. R. Damon.
2. Frame and Pile Trestles Complete, including Rerailer	H. M. Hall, W. A. McGonagle, G. W. McGehee.
3. Framing and Protection of Howe Truss and Other Wooden Bridges against Fire and Decay	J. E. Johnson, G. W. Markley, J. H. Markley.
4. Iron and Vitrified Pipe for Waterways under Railroad Embankments	James Stannard, J. O. Thom, J. E. Wallace.
5. Water Tanks Complete, including Painting, Pumps, Pump and Coal Houses, Wells and Reservoirs	G. W. Turner, R. K. Ross, Q. McNab.
6. Interlocking Signals	B. F. Bond, G. M. Hinman, James DeMars.
7. Depot Platforms, Complete	J. A. Nicholson, Adam McNab, C. B. Keller.
8. Paints for Iron Structures	Geo. M. Reid, A. J. Kelley, H. A. Hanson.

SECOND CONVENTION, CINCINNATI, O., OCTOBER 18 AND 19, 1892.

Subjects.	Committees.
1. Discipline, and Benefits Derived, and Who are the Beneficiaries	Geo. W. Andrews, W. R. Damon, T. M. Strain, G. W. Turner.
2. Turntable, Best, with a View of Economy, and Durability, and Strength	G. W. Markley, H. F. Martin, James H. Travis, Charles Walker.
3. Water Columns, Best, Cheapest, Simplest, and Most Durable	C. E. Fuller, A. S. Markley, H. N. Spaulding, E. L. Cary.
4. Coaling Stations, including Storage Bins and for Coaling Engines	J. E. Wallace, C. W. Gooch, G. H. Himman, J. H. Cummin.
5. Crawling of Rails, and its Effects on Structures	Geo. M. Reid, L. K. Spafford, J. B. Mitchell, L. S. Isdell.

6.

Guard Rails on Bridges, Advantages and Disadvantages, and Best to be Adopted	O. J. Travis, Q. McNab, J. F. Mock, J. M. Staten.

7.

Platforms, Height and Distance from Rail and Mode of Construction	James Stannard, M. Walsh, N. M. Markley, Robert Ogle.

8.

Best Bridge, Wood, Combination or Iron from 130 feet and upwards, and the Best Method of Reconstruction	A. Shane, Walter Ransom, N. Potter, C. G. Worden.

9.

Best Method of Elevating Track upon Bridges and Trestles	H. E. Gettys, S. F. Patterson, G. W. Hinman, P. A. Watson.

THIRD CONVENTION, PHILADELPHIA, PA., OCTOBER 17, 18, AND 19, 1893.

1.

Depressed Cinder Pits and Other Kinds	W. G. Berg, Abel S. Markley, G. W. Andrews, C. E. Fuller.

2.

Best Method of Bridge Inspection	G. M. Reid, J. M. Staten, E. T. Wise, J. S. Berry.

3.

Pumps and Boilers	G. W. Markley, G. W. Turner, J. B. Mitchell, J. R. Harvey.

4.

Maintenance of Pile and Frame Trestle	W. A. McGonagle, J. H. Markley, Geo. C. Nutting, John Copeland.

5.

The Best Scale Foundation	O. J. Travis, Joseph Doll, C. E. Wadley, T. M. Strain,

FOURTH CONVENTION, KANSAS CITY, MO., OCTOBER 16, 17, AND 18, 1894.

1.

Mechanical Action and Resultant Effects of Motive Power at High Speed on Bridges	G. W. Andrews, W. G. Berg, J. E. Greiner, E. H. R. Green.

2.

Methods and Special Appliances for Building Temporary Trestles over Washouts and Burnouts	R. M. Peck, G. J. Bishop, A. B. Manning, C. D. Bradley.

3.

Strength of Various Kinds of Timber Used in Trestles and Bridges, Especially with Reference to Southern Yellow Pine, White Pine, Fir and Oak	W. G. Berg, J. H. Cummin, John Foreman, H. L. Fry.

4.

Best Method of Erecting Plate Girder Bridges	H. M. Hall, J. M. Staten, G. W. Hinman, J. N. Pullen.

5.

Best and Most Economical Railway Track Pile Driver	J. L. White, A. C. Davis, J. F. Mock, James T. Carpenter.

6.

Sand Dryers, Elevators, and Methods of Supplying Sand to Engines, including Buildings	Aaron S. Markley, H. A. Hanson, A. J. Kelley, J. O. Thorn.

7.

Span Limits for Different Classes of Iron Bridges, and Comparative Merits of Plate Girders and Lattice Bridges for Spans from 50 to 110 feet	W. A. McGonagle, R. M. Peck, W. M. Noon, H. E. Gettys.

8.

Best Method of Spanning Openings too Large for Box Culverts, and in Embankments too Low for Arch Culverts	James Stannard, L. K. Spafford, O. H. Andrews, F. W. Tanner.

9.

Best End Construction for Trestle Adjoining Embankments	G. M. Reid, J. L. Soisson, N. M. Markley, R. J. Howell.

10.

Interlocking Signals	J. H. Travis, W. S. Danes, R. L. Heflin, J. A. Spangler.

11.

Pumps and Boilers	John H. Markley, O. J. Travis, A. Shane, G. W. Markley.

FIFTH CONVENTION, NEW ORLEANS, LA., OCTOBER 15 AND 16, 1895.

1.

How to Determine Size and Capacity of Openings for Waterways	Aaron S. Markley, J. S. Berry, C. C. Mallard, J. L. White.

2.

Different Methods of Numbering Bridges. Should All Waterways be Numbered?	A. Shane, W. O. Eggleston, J. L. Soisson, O. J. Travis.

3.

Drawbridge Ends, Methods of Locking; and under this head include Locking of Turntables	H. M. Hall, James Stannard, H. Middaugh, C. C. Mallard.

4.

Protection of Trestles from Fire, including Methods of Construction	R. M. Peck, T. H. Kelleher, A. McNab, W. M. Noon, G. W. Hinman, William Berry.

5.

Local Stations for Small Towns and Villages, giving Plans of Buildings and Platforms	J. H. Cummin, N. M. Markley, J. H. Markley, C. G. Worden.

6.

Tanks, Size, Style, and Details of Construction, including Frost-proof protection to Tank and Pipes	W. O. Eggleston, W. M. Noon, A. McNab, N. W. Thompson.

7.

Shearing of Rivets in Plate Girders and Cause Thereof.	J. M. Staten, R. L. Heflin, J. H. Travis, G. M. Reid.

8.

Best and Uniform System of Report Blanks for Bridge and Building Department	G. J. Bishop, W. O. Eggleston, Onward Bates, M. Riney.

9.

Protection of Railroad Structures and Buildings from Fire	Charles Parsons, R. M. Peck, L. K. Spafford, B. T. McIver.

10. Brought forward from 1894.

Mechanical Action and Resultant Effects of Motive Power at High Speed on Bridges	G. W. Andrews, W. G. Berg, J. E. Greiner. E. H. R. Green.

11. Brought forward from 1894.

Best and Most Economical Railway Track Pile Driver	J. L. White, A. C. Davis, J. F. Mock, J. T. Carpenter, G. W. Hinman.

12. Brought forward from 1894.

Span Limits for Different Classes of Iron Bridges, and Comparative Merits of Plate Girders and Lattice Bridges for Spans from 50 to 110 feet	W. A. McGonagle, R. M. Peck, W. M. Noon, H. E. Gettys, G. J. Bishop, Onward Bates.

13. Brought forward from 1894.

Interlocking Signals	J. H. Travis, W. S. Danes, R. L. Heflin, J. A. Spangler.

DIRECTORY OF MEMBERS.

OCTOBER, 1895.

Anderson, C. W., N. & W. R. R., Graham, Va.
Andrews, George W., Philadelphia Div. B. & O. R. R., 24 Chestnut st., Phila.
Andrews, O. H., St. Jo. & G. I. & K. C. Ry., Elwood, Kan.
Austin, Cyrus P., B. & M. R. R., Medford, Mass.
Bates, Onward, C., M. & St. P. Ry., and M. & N. Ry., Chicago, Ill.
Berg, Walter G., Lehigh Valley Ry., Jersey City, N. J.
Berry, J. S., S. T. S. W. Ry., Tyler, Texas.
Berry, William, San Antonia & Arkansas Pass Ry., Yoakum, Texas.
Bishop, George J., C., R. I. & P. Ry., Topeka, Kan.
Bricker, J. A., Norfolk & Western Ry., Shenandoah, Va.
Bradley, C. D., St. L. & San Francisco Ry., Tex. Div., Fort Smith, Ark.
Boyce, Joseph W., L. E. & St. L. C. R. R., Huntingburgh, Ind.
Brady, James, Chicago, Rock Island & Pacific Ry., Davenport, Iowa.
Carmichael, William, U. Pac. R. R., Junction City, Kan.
Carpenter, James T., ...Lexington, Ky.
Cary, E. L., M. R. & B. T. R. R., Bonne Terre, Mo.
Cahill, M. F., Norfolk & Western Ry., Lynchburg, Va.
Cummin, Joseph H., Long Island R. R., Long Island City, N. Y.
Damon, W. R., Louisville, Nashville & St. L. Rd. Co., Huntingburgh, Ind.
Danes, William S., Wabash R. R., Eastern Div., Andrews, Ind.
Davis, A. C., Birmingham, Shef. & Tenn. Riv. Ry. Co., Sheffield, Ala.
Doll, Joseph, C., C., C. & St. L. Ry. Co., Batesville, Ind.
Eggleston, William O., C. &. Erie R. R., Huntington, Ind.
Ennes, I. R., South Carolina Ry., Branchville, S. C.
Foreman, John, Phila. & Read. R. R., Pottstown, Pa.
Fry, H. L., Cape Fear & Yankin Valley R. R., Greensboro, N. C.
Fitz, Patrick M. J., C., C., C. & St. L. R. R., Sandusky, Ohio.
Garvey, M. M., Iowa Central R. R., Marshalltown, Iowa.
Gettys, Henry E., Norfolk & Western Ry., Roanoke, Va.
Gooch, C. W., Iowa Central R. R., Marshalltown, Iowa.
Graham, T. B., Northern Pacific Ry., Little Falls, Minn.
Green, E. H. R., Texas Midland R. R., Terrell, Texas.
Green, William, Mich. Div., C., C., C. & St. L., Wabash, Ind.
Grenier, J. E., B. & O. R. R., Baltimore, Md.
Hall, H. M., Ohio & Miss. Ry., Olney, Ill.
Hanks, George E., Flint & Pere Marquette Ry., East Saginaw, Mich.
Hanson, H. A., C., C., C. & St. L. Ry. Co., Mt. Carmel, Ill.
Harvey, James R., St. L., I. M. & S. Ry., Little Rock, Ark.
Heilder, W. H., N. &. W. Ry., Shenandoah, Va.
Heflin, R. L., B. & O. Ry., Grafton, W. Va.
Hildebrand, J. D., A., T. & S. F. R. R., Chanute, Kansas.
Hines, E. D., Norfolk & Western Ry., Portsmouth, Ohio.

Howell, Robert J., Wheeling Bridge & Terminal Ry., Wheeling, W. Va.
Houston, John, Wilmington & Northern Ry., Springfield, Pa.
Hinman, G. W., Louisville & Nashville R'd Co., Evansville, Ind.
Ingalls, F., Nor. Pacific R. R., Jamestown, N. D.
Ingram, Floyd, Louisville & Nashville R'd Co., Erin, Tenn.
Isaacs, John D., Southern Pacific Co., San Francisco, Cal.
Johnson, J. E., Toledo, St. Louis & Kansas City R'd, Charlestown, Ill.
Kelleher, T. H., New Orleans & N. E. R'd Co., New Orleans, La.
Keller, C. B., C., C., C. & St. L. Ry. Co., Cambridge City, Ind.
Kelley, A. J., K. C. Belt Ry. Co., Kansas City, Mo.
King, A. H., Union Pacific Ry., Cheyenne, Wyo.
Kyser, Charles W., Mo. Pac. R. R., El Dorado, Kansas.
Loughery E., Texas & Pacific Ry., Marshall, Tex.
Markley, Aaron S., Chicago & Eastern Ill. R. R. Co., Danville, Ill.
Markley, John H., Toledo, Peoria & Western Ry. Co., Peoria, Ill.
Markley, N. M., C., C., C. & St. L. Ry. Co., Arcanum, Ohio.
Markley, G. W., C., C., C. & St. L. Ry. Co., Crawfordsville, Ind.
Markley, Abel S., Pittsburg & Western Ry. Co., Alleghany, Pa.
Mallard, Charles C., Southern Pacific Ry., Algiers, La.
Martin, M. A., M., K. & T. Ry., Parsons, Kansas.
Manning, A. B., M., K. & T. Ry., Parsons, Kansas.
McGehee, G. W., Mobile & Ohio R'd Co., Okolona, Miss.
McGonagle, W. A., Duluth & Iron Range R'd Co., Two Harbors, Minn.
McIvers, B. T., St. Paul & Duluth Ry. Co., St. Paul, Minn.
McNab, Quintine, Terra Haute, Ind.
McNab, A., Chi. & West Mich. Ry., Holland, Mich.
Middaugh, H., Seattle, Lake Shore & Eastern Ry. Co., Seattle, Wash.
Midwinter, Joseph, D., G., H. & M. Ry. Co., Grand Rapids, Mich.
Millener, S. S., B. & O. Southwest R. R., Washington, Ind.
Mitchell, W. B., N. Y., P. & O. R. R., Galion, Ohio.
Mock, J. F., Ohio River R'd Co., Parkersburg, W. Va.
McCurda, James, A., T. & Santa Fe R'd, Merceline, Mo.
Nutting, George C., C., C. & C. R. R., Blacksburg, S. C.
Noon, W. M, Duluth, South Shore & Atlantic Ry., Marquette, Mich.
Olney, A. C., Charleston, S. C.
Olmstead, J. O., Central Vermont R. R., St. Albans, Vt.
Osborne, Frank C., Valley Ry., Cleveland, Ohio.
Pasco, W. F., Lehigh R. R., Easton, Pa.
Parker, John F., Southern California Ry., San Bernardino, Cal.
Patterson, Samuel F., Boston & Maine, Concord, N. H.
Potter, M. E., C., C., C. & St. L. Ry. Co., Franklin, Ohio.
Pullen, J. B., B. & O. Ry. S. W., Chillicothe, Ohio.
Peck, R. M., Missouri Pac. and St. L., I., M. & S. Ry., Pacific, Mo.
Ransom, Walter, Alabama Great Southern Ry., Birmingham, Ala.
Reid, G. M., Lake Shore & Mich. Southern Ry. Co., Cleveland, Ohio.
Ross, R. K., Detroit, Lansing & Northern Ry., Iona, Mich.
Ryan, George W., K. C., Fort Scott & Memphis Ry. Co., Thayer, Mo., Ore. Co.
Rhoads, E. F., C., C., C. & St. L. Ry., Springfield, Ohio.
Riney, M., C. & N. W. R. R., Barraboo, Wis.
Schenck, W. S., B. & O. R. R. (P. H. Div.), Connellsville, Pa.
Shane, A., C., C., C. & St. L. Ry. Co., Lafayette, Ind.
Short, M. D., K. C. Belt R. R., Kansas City, Mo.
Soisson, J. L., Wheeling & L. Erie Ry. Co., Norwalk, Ohio.
Smith, L. D., Eastern Div. N. & W. Ry., Petersburg, Va.
Snow, J. P., B. & M. R. R., Boston, Mass.
Spangler, J. A., Pittsburg Div. B. & O. Ry., Washington, Pa.

SPAFFORD, L. K., K. City, Fort Scott & Memphis Ry., Kansas City, Mo.
SPAULDING, H. N., Cinc., Hamilton & Ind. Ry., Connersville, Ind.
STANNARD, JAMES, Wabash Ry., Moberly, Mo.
STRAIN, T. M., Wabash Ry., Decatur, Ill.
STATEN, JOSEPH M., Ches. & Ohio Ry., Richmond, Va.
TANNER, FRANK W., Missouri Pacific Ry., Atchison, Kansas.
THORN, J. O., C., B. & Q. Ry. Co., Beardstown, Ill.
THOMPSON, N. W., P., F. W. & C. Ry., Western Div., Ft. Wayne, Ind.
TILLEY, CHARLES M., Mex. National R. R., Laredo, Tex.
TITLEY, J. W., Ft. Worth & Denver City Ry., Clarendon, Tex.
TRAVIS, James H., Ill. Cent. Ry., Chicago, Ill.
TRAVIS, O. J., Elgin, J. & E. Ry., Joliet, Ill.
TURNER, G. W., St. L. & San Francisco Ry., Springfield, Mo.
VANDERGRIFT, C. W., C. & O. Ry., Huntington Div., Alderson, W. Va.
WADDELL, CHARLES E., C. V. Div. N. & W. R. R., Richmond, Va.
WALLACE, J. E., Wabash R. R., Springfield, Ill.
WARD, THOMAS N., Ohio Valley Ry., Henderson, Ky.
WATSON, P. N., Maine Central R. R., Bartlett, N. H.
WEED, J. A., Union Pacific Ry., Pendleton, Ore.
WELKER, GEORGE W., W, and O. Div., R. & D. Ry., Alexandria, Va.
WHITE, J. L., Texas Midland R. R., Terrell, Texas.
WISE, E. T., Ill. Central Ry., Waterloo, Ia.
WILKINSON, JONATHAN M., Cinc., Jackson & M. Ry., Van Wert, Ohio.
WORDEN, C. G., S. Cal. Ry. Co., Los Angeles, Cal.

DECEASED MEMBERS.

DEMARS, James, Wheeling & L. Erie R. R., Norwalk, Ohio.
DUNLAP, H., Wabash R. R., Andrews, Ind.
FULLER, C. E., T. H. & I. R. R., Terra Haute, Ind.
ISADELL, L. S., O. & M. R. R., Lawrenceburgh, Ind.
TOZZER, WILLIAM S., C. & O. R. R., Cincinnati, Ohio.
TRAUTMAN, J. J., S. C. R. R., Edgefield, S. C.

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PROCEEDINGS

OF THE

SIXTH ANNUAL CONVENTION

OF THE

Association of Railway Superintendents of Bridges and Buildings,

HELD IN CHICAGO, ILLINOIS,

OCTOBER 20, 21, AND 22, 1896.

CONCORD, N. H.
PRINTED BY THE REPUBLICAN PRESS ASSOCIATION.
1896.

OFFICERS.

JAMES STANNARD, ... PRESIDENT.
Wabash Railroad, Moberly, Mo.

WALTER G. BERG, ... FIRST VICE-PRESIDENT.
Lehigh Valley Railroad, Jersey City, N. J.

JOSEPH H. CUMMIN, ... SECOND VICE-PRESIDENT.
Long Island Railroad, Long Island City, N. Y.

AARON S. MARKLEY, ... THIRD VICE-PRESIDENT.
Chicago & Eastern Illinois Railroad, Danville, Ill.

R. M. PECK, ... FOURTH VICE-PRESIDENT.
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Duluth, South Shore & Atlantic Railway.

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Chicago, Rock Island & Pacific Railway.

C. P. AUSTIN, ... Medford, Mass.
Boston & Maine Railroad.

M. RINEY, ... Barraboo, Wis.
Chicago & Northwestern Railway.

PROCEEDINGS OF THE SIXTH ANNUAL CONVENTION

OF THE

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS,

HELD IN CHICAGO, ILL., OCTOBER 20, 21, AND 22, 1896.

The convention was called to order at 10 a. m., October 20, 1896, at the Leland Hotel, Chicago, Ill., with President W. A. McGonagle in the chair, a number of ladies being present at the opening exercises.

PRESIDENT.—It is meet and proper before commencing the business of our convention that we invoke the blessing of Almighty God. I will, therefore, ask Mr. J. H. Cummin, of the Long Island road, to offer prayer.

Prayer was then offered by Mr. Cummin.

Mr. J. H. Travis, chairman of the local committee, introduced Mr. George A. Dupuy, representing the mayor of the city of Chicago.

Mr. George A. Dupuy then addressed the association as follows:

MR. PRESIDENT, MEMBERS OF THE ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS, LADIES AND GENTLEMEN:

I am very sorry indeed that I am placed in the embarrassing position in which I find myself, and that the mayor is unable to be with you this morning to address you. I happen to be a member of his official staff as assistant corporation counsel of the city, so that I suppose he considers he has a right to call on me when occasion demands. As you know, the mayor is greatly occupied, and it is very hard for him to get away at times. On such occasions, when he is unable to attend in person, he frequently requests me to go as his substitute and speak to an assembly or whatever kind of a gathering it may be, and you can imagine it is not a very pleasant matter for me to go, on very short notice, and, particularly on an occasion of this kind, when,

doubtless, something is expected and looked for. It certainly, however, is not very difficult to say that we are very glad to see you. Chicago is always glad to see conventions of this sort and to heartily welcome them.

The mayor did not say what I was to talk to you about this morning, but I suppose and take it for granted that he wants me to talk to you about Chicago. If a Chicago man has a great deal of time on his hands to prepare a speech, he talks about Chicago; and if he has but little time to make his preparations, he talks about Chicago. So I should not be keeping up the record in appearing before you to-day, if I did not speak to you about Chicago.

In the earlier history of this city, we used to be thought of by the world as persons wholly engrossed in material things. The stock-yards and the lumber market were the principal things in Chicago in those years gone by. We had bad streets, badly built houses, bad roads, and a great many bad odors that came from the rivers and from certain districts of Chicago. Chicago had not then the reputation that it could have wished, but I think we can now stand comparison with other cities, that we have outgrown that condition of things. We can show you many institutions here in our midst that I think will interest you. We have very much yet to learn and to accomplish, but we have made some advancement along the lines I have spoken of toward better conditions. We are proud of our Art Institute and our Newberry Library; we are proud of the bequest made by a late public-spirited citizen connected with the railroad interests for a Reference library on the South side,—I mean the late Mr. Crerar; we are proud of our parks and boulevards, and we are proud of that beautiful "White City" we built in our midst, the finest exhibition the world has ever seen. So we do not feel like apologizing to you for the Chicago of a few years ago, in the face of the strides we have made.

Certainly, Chicago could not welcome a class of people more heartily than it should those connected with the railroad interests of the country, of which your association is so representative. It is the railroad that has made possible nearly everything that we enjoy to-day. These iron bands stretch out from Chicago in every direction, as though Chicago was a great central hub, carrying merchandise to and from every conceivable point,—bringing us lumber from the North, and running to the prairies for the products of the farmer, to the East for the manufactured products of our own and other lands, and to the South, and in every direction; so that it is the railroads more than anything else that have made possible the growth and development that have been witnessed here. So we can very heartily say, if there is any class of interests that deserve to be spoken of better than others by Chicago, it is the railroad interests. It would seem almost unnecessary to say anything on this particular head, but perhaps you have not thought of it yourselves, because when we are in the midst of daily cares and duties, going along well-defined and ordered lines, we do not have the time or opportunity to indulge in reflection or retrospection.

But it is marvelous how the railroads of this country have developed and grown during the past fifty or seventy years. You will excuse the personal character of the remark, but it is something that could not be said by many persons: My ancestors for three generations back of myself spent their lives in Illinois, and not one of them was as far east as Ohio, and it was not until a few years ago that I myself made a trip to the city of Boston. Now you can see for yourselves how railroads have multiplied since those earlier days, and how facilities have increased for travel. Since then, the roads have stretched out on every hand throughout the length and breadth of this country, and we

witness the amazing result that has taken place. I remember during my boyhood days how I used to sit on the fence posts and watch the trains coming and going miles away. Sometimes I climbed up on the railroad tracks and looked up and down the length of those bright, shining rails, and wondered as to the world that lay beyond. I wondered where I would be taken to [Laughter] if I could only get on one of the trains and be carried away to the end of that road which seemed to me so endless. But things have changed somewhat. The world of to-day is not the world of yesterday. We all hope to be, and all are, factors, in greater or less degree, in its advancement and progress. Gentlemen and ladies, all, we welcome you most heartily to our city.

The President then responded as follows:

MR. DUPUY:

As representing the mayor of the city of Chicago, on behalf of the Association of Railway Superintendents of Bridges and Buildings, I desire to thank you for your warm words of greeting and your hearty welcome.

Chicago has become the ideal American city. Its thrift, business energy, enterprise, and progress are known throughout the world. Its educational advantages are unparalleled by any city in our country, and its manufactures cover almost every line of business.

To such a city we are glad to bring our convention, well knowing the benefit to be derived by each and every member of our association. The motto of your city, "I will," is the key-note of your success, and expresses the determination that is necessary for us to assert in times of accident and disaster. "I will" will clear a wreck or renew a burned structure in the shortest possible time, and for this reason we will drink deep of the spirit of your motto, and when your drainage canal is completed, we may be induced to drink deep of your Lake Michigan water. We admire the spirit of your merchant princes in their loyal support of the educational institutions of your city. We have been told that no other American city ever could have produced and carried to a successful termination the palatial and stately World's Fair. We believe fully that statement, and when we see in times of great financial depression the progress you are making toward the new Columbian Museum, and, above all, when we see the success of the greatest of universities, the University of Chicago, we must admire and congratulate the people of the city of Chicago in their wise forethought in providing a liberal education for all the people within her borders.

Again thanking you for the welcome extended by your city, we invite you to remain in attendance upon all the sessions of our convention.

Mr. Dupuy.—I thank you for your invitation to remain, but I am a very busy man, and shall be obliged to go before your meeting is over, probably. I hope the members will not think I am lacking in courtesy if I am obliged to retire before the close of their session.

President.—The calling of the roll is next in the order of business.

The secretary then called the roll, as follows; thirty-three members answered the roll-call, and others came in later:

MEMBERS PRESENT AT ROLL-CALL.

O. H. ANDREWS, St. Jo. & G. I. & K. C. Ry., Elwood, Kansas.
CYRUS P. AUSTIN, B. & M. R. R., Medford, Mass.
ONWARD BATES, C. M. & St. P. Ry., Chicago, Ill.
WALTER G. BERG, Lehigh Valley R. R., Jersey City, N. J.
GEORGE J. BISHOP, C. R. I. & P.Ry., Topeka, Kansas.
E. L. CARY, M. R. & B. T. R. R., Boone Terre, Mo.
JOSEPH H. CUMMIN, L. Island Railroad, Long Island City, N. Y.
WM. S. DANES, Wabash R. R., Andrews, Ind.
WM. O. EGGLESTON, C. & Erie R. R., Huntington, Ind.
JOHN FOREMAN, Phila. & Reading R. R., Pottstown, Pa.
M. M. GARVEY, Iowa Central R. R., Marshalltown, Iowa.
ROBERT J. HOWELL, W. B. & T. Ry., Wheeling, W. Va.
G. W. HINMAN, L. & N. R. R., Evansville, Ind.
AARON S. MARKLEY, C. & E. I. Ry., Danville, Ill.
JOHN H. MARKLEY, T. P. & W. Ry., Peoria, Ill.
N. M. MARKLEY, C. C. C. & St. L. Ry., Arcanum, Ohio.
W. A. MCGONAGLE. D. & I. R. Ry., Two Harbors, Minn.
A. MCNAB, Chicago & West. Mich. Ry., Holland, Mich.
W. M. NOON, D. S. S. & A. Ry., Marquette, Mich.
J. O. OLMSTEAD, Cent. Vermont R. R., St. Albans, Vt.
S. F. PATTERSON, B. & M. R. R., Concord, N. H.
M. RINEY, C. & N. W. Ry., Barraboo, Wis.
J. A. SPALDING, B. & O. Ry., Washington, Pa.
JAMES STANNARD, Wabash Ry., Moberly, Mo.
T. M. STRAIN, Wabash Ry., Decatur, Ill.
J. O. THORN, C. B. & Q. Ry., Beardstown, Ill.
N. W. THOMPSON, P. F. W. & C. Ry., Fort Wayne, Ind.
JAMES H. TRAVIS, Ill. Cent. Ry., Chicago, Ill.
O. J. TRAVIS, E. J. & E. Ry., Joliet, Ill.
ABEL S. MARKLEY, P. & W. Ry., Alleghany, Pa.
GEORGE C. NUTTING, O. R. & C. R. R., Blacksburg, S. C.
J. E. JOHNSON, T. St. L. & Kansas City R. R., Charlestown, Ill.
A. J. KELLEY, K. C. Belt Ry., Kansas City, Mo.

The following applicants for membership, subsequently elected, were present:

C. M. LARGE, master carpenter, B. & B., E. & P. R. R., Jamestown, Pa.

WM. B. YEREANCE, engineer B. & B., West Shore R. R., Weehawken, N. J.

JAMES MCINTYRE, master carpenter, Erie R. R., Cleveland, O.

President.—The next business in order is the reading of the minutes.

It was resolved that as the minutes had already been published, and in the hands of the members for a considerable length of time, that the reading of same be dispensed with.

President.—The next business is the report of the Committee on Application for Membership.

Mr. Berg.—By request of Mr. G. W. Hinman, member of the Application Committee, I will read the following nineteen applications that have been recommended by the Committee for Membership:

W. E. Harwig, master carpenter, Lehigh Valley R. R., Philipsburg, N. J.
F. R. Martin, master carpenter bridges, Cleveland & Pittsburgh R. R., Wellsville, O.
Holland W. Fletcher, general inspector of bridges, Chicago & Northwestern R. R., Chicago, Ill.
F. N. Apple, master carpenter buildings, Cleveland & Pittsburgh R. R., Cleveland, O.
C. M. Large, master carpenter, B. & B., Erie & Pittsburgh R. R., Jamestown, Pa.
Edward F. Reynolds, superintendent B. & B., Chicago & Northwestern R. R., Ashland, Wis.
Wm. B. Yereance, engineer B. & B., West Shore R. R., Weehawken, N. J.
W. R. Cannon, general foreman B. & B., Chicago, Rock Island & Pacific Ry., Herington, Kan.
J. C. Jennings, supervisor B. & B., C. C. C. & St. L. Ry., Wabash, Ind.
G. J. Klump, supervisor B. & B., C. C. C. & St. L. Ry., Mattoon, Ill.
Benj. Wilder Guppy, assistant bridge engineer, Boston & Maine R. R., Boston, Mass.
James McIntyre, master carpenter, Erie R. R., Cleveland, Ohio.
J. L. Neff, supervisor B. & B., Chicago & Northern Pacific R. R., Chicago, Ill.
J. B. Tippett, superintendent B. & B., P. & P. U. Ry., Peoria, Ill.
Walter A. Rogers, assistant engineer B. & B., Chicago, Milwaukee & St. Paul R. R., Chicago. Ill.
James D. Gilbert, superintendent bridges M. K. & Texas Ry., Parsons, Kan.
Gilman W. Smith, assistant superintendent B. & B., Chicago, Milwaukee & St. Paul R. R., Chicago, Ill.
Wm. Reed, Jr., bridge inspector, Illinois Central R. R., Chicago, Ill.
James Rogers, supervisor B. & B., New York, Chicago & St. Louis R. R., Fort Wayne, Ind.

Mr. Berg.—I also have an application for membership, which is referred by Mr. G. W. Hinman, member of the Application Committee, to the association, for further action, namely:

Application of Mr. Henry Goldmark, bridge engineer, Chicago, Ill.

President.—What action will you take on the application of these members as read for membership in our association? You will first act on the regular list, as endorsed by the Committee on Applications.

On motion, duly seconded and carried, the nineteen applicants on the list as recommended by the Application Committee, were unanimously elected.

President.—What action will the association take in regard to the application of Mr. Goldmark?

Mr. Goldmark was highly recommended by several members, and on a suitable motion being made, was unanimously elected as a member.

A short recess was then taken, for the purpose of welcoming the new members.

Handsome association badges, presented to the association by the Sherwin-Williams company, were distributed to the members.

On resuming, the president delivered his annual address as follows:

To the Officers and Members of the Association of Railway Superintendents of Bridges and Buildings:

At the close of another year in the history of our association, we meet under favorable auspices for the work of our sixth annual convention. The past year has been a very prosperous one for our association; we have grown in numbers and importance, and have been accorded a place, a prominent place, among the learned societies of the United States. This place we must hold and make more prominent by faithful work on the part of each and every member of our association. We must move forward in the cause of disseminating useful knowledge among our members to their benefit and to the benefit of every railroad company throughout our country.

As we meet once more the many old friends, and greet for the first time our new members, we must pause to pay tribute to the memory of those who have passed over the bridge of life which spans the valley of the river of death and joins the shores of this transitory existence with the shores of eternity. We miss their familiar faces among us; we shall miss their counsels and their ripe experience in our discussions.

Thomas B. Graham, who was Supervisor of Bridges and Buildings of the Duluth & Iron Range Railroad, died September 1st, 1895, at Two Harbors, Minn., and

George M. Reid, Treasurer of our association from its organization, and who was Superintendent of Bridges of the Lake Shore and Michigan Southern Railway, died on February 10th, 1896, at Cleveland, Ohio.

Both of these members were very dear personal friends of mine, and one of them, George M. Reid, was the personal friend of every member who ever attended a convention of our association.

Thomas B. Graham, although a member of our association since the year 1893, never attended our conventions, his busy life preventing him from leaving his work; he was an earnest, warm-hearted and capable man, and those of our members who were permitted to have his friendship will ever treasure his memory.

George M. Reid, our late treasurer, was known to us all, and each of us can and will add our tribute to his memory. I desire to lay upon his grave my tribute to the manly, Christian gentleman. Ripe in experience, we shall ever miss his counsel; plain and unassuming, we shall ever miss his friendship; happy and jovial, we shall ever miss his hearty handshake and his cheering words. His life, although terminated in its meridian, was complete, and in his death we lose an active, earnest and capable member, whose memory will always be an inspiration.

On May 10th, in response to a call by the chairman of the Executive Committee, I attended a meeting of that committee in the city of Chicago to discuss detailed plans for this convention. At this meeting, it was decided to hold the sixth annual convention at the Leland Hotel, and a local committee, consisting of Messrs. J. H. Travis, Aaron S. Markley, G. J. Bishop and O. J. Travis, was appointed to look after the detailed plans for the entertainment and comfort of the convention.

In March last, I signed a petition to a committee of the United States Senate, asking favorable action upon Senate Bill No. 1214 to provide the Forestry Division of the Department of Agriculture with sufficient funds to continue the valuable series of timber tests they have in hand. This matter was brought to my attention by our Mr. Berg, and I would recommend that further action be taken by this association to secure the continuance of these valuable experiments.

On September 4th, I attended a meeting of officers of our association in the city of New York, to complete the programme for this convention. At this meeting, there were present Messrs. Berg, Patterson, Cummin and myself.

The assignment of committees, while not always satisfactory, should find every member ready and willing to work. If he is not posted on the subject upon which he is to write, he will never in his life get a better chance to become thoroughly posted, and it is only through deep study and active research that the best results are obtained.

Let us above all things select practical and modern subjects and confine our subjects to our own department, allowing all subjects that belong to the Engineering or Track departments to be settled by the American Society of Civil Engineers, or the Roadmasters' Association of America, both of which bodies are fully competent to handle subjects in their special spheres.

Let us in our deliberations endeavor to be brief, concise, and to the point, and always practical. In this way, we can add new laurels to those already won among the learned societies.

And now with a deep sense of gratitude for the high honor you bestowed on me one year ago at New Orleans, and gratefully acknowledging the feeling of sympathy expressed for me by our members at a time of great sorrow, and trusting that my work during the past year has merited the confidence you reposed in me, I can only ask that you continue to give the same cordial support to my successor in office, and I can assure you that I shall always keep the interest of this association at heart, and shall always aid in promoting its welfare.

W. A. McGonagle, *President.*

President.—The next business in order is the report of the secretary and treasurer. I will explain to the convention that at the time of the death of our treasurer, the Executive Committee requested the secretary to act as treasurer, until the

meeting of the sixth convention, the treasurer's report being included in the secretary's report.

Mr. S. F. Patterson then read these reports, as follows:

TO THE OFFICERS AND MEMBERS OF THE ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS:

GENTLEMEN:—Your secretary submits the following report:

The fifth annual report was issued as soon as possible after the adjournment of the convention at New Orleans, and distributed to the members, the technical press, and societies of the country.

Our membership list now numbers one hundred and twenty-one—two members having asked to be dropped from the roll. Since our last meeting, we have been twice reminded of the shortness of time, and two of our members have been called hence. Mr. T. B. Graham, of the Northern Pacific, and our worthy treasurer, G. M. Reid, of the Lake Shore & Michigan Southern. We mourn, and feel our loss, especially of our genial friend, Mr. Reid, as we had been associated with him and always met him at our conventions.

The Executive Committee was called together at Chicago, March 10, to complete arrangements for our sixth convention. A report of their proceedings is submitted.

FINANCIAL.

Dr.

Received from the former treasurer................. (the amount in his hands as per report.)	$210.68	
" from all other sources.....................	966.04	
		$1,176.72

Cr.

Expenses, for which I hold vouchers................	$848.06	
		$848.06
Balance in hands of secretary.................		$328.66

Respectfully submitted,

S. F. PATTERSON,
Secretary and Acting Treasurer.

On motion, the report as read was received and referred to the Auditing Committee.

President.—The next business in order is the payment of annual dues. The secretary will now receive the annual dues, during which time the convention will have a recess.

President.—We will hear the report of the Executive Committee.

Mr. Berg then read the report, as follows:

REPORT OF MINUTES OF MEETING OF EXECUTIVE COMMITTEE, HELD IN CHICAGO ON MARCH 10, 1896,

A meeting of the Executive Committee of the Association of Railway Superintendents of Bridges and Buildings, was held at the Great Northern Hotel, in the city of Chicago, Ill., on Tuesday, March 10, 1896, at 12 o'clock, noon, to discuss plans for the sixth annual convention, which meets in Chicago on October 20, 1896.

In the absence of the chairman of the executive board, the meeting was called to order by the president, W. A. McGonagle. Mr. R. M. Peck, chairman of the Executive Committee, on account of serious illness in his family, sent his proxy to W. A. McGonagle.

Members present: W. A. McGonagle, A. Shane, A. S. Markley, W. M. Noon, R. M. Peck (Proxy).

Mr. A. S. Markley was appointed secretary *pro tem.*

On motion of Mr. A. Shane, the president was instructed to draft a suitable resolution on the death of our late treasurer, George M. Reid, on behalf of the Executive Committee, and transmit the same to Mrs. Reid.

On motion of A. Shane, seconded by A. S. Markley, the secretary was instructed to furnish all officers of the association with four copies each, of the proceedings of the association, and all other members with two copies each, and all advertisers with one copy each; additional copies to be furnished on request, by paying cost of production and postage. Also, to furnish all educational institutions applying for copies of the proceedings, with one copy each, free of charge. In case of public libraries and others applying for copies, they shall pay the cost of production and postage.

On motion of A. Shane, seconded by W. M. Noon, the secretary was instructed to receive and hold all monies belonging to the association, until a successor to our late treasurer is elected at the next annual meeting.

On motion of A. S. Markley, seconded by W. M. Noon, the secretary was instructed to prepare and publish a programme for our next annual convention, and furnish each member with a copy, at least one week in advance of the meeting.

On motion of A. Shane, seconded by W. M. Noon, the president appointed J. H. Travis, A. S. Markley, G. J. Bishop, and O. J. Travis, a local committee to attend to all details pertaining to the comfort and entertainment of the convention.

On motion of A. Shane, seconded by A. S. Markley, the Leland hotel was selected as the place for holding our next annual convention, rates to be $2.50 per day, each, for rooms without bath, the hotel to furnish a club-room, for the sessions of the convention, free of charge.

A programme for the annual meeting in Chicago, on October 20, 1896, was then arranged.

W. A. McGonagle,
President and Acting Chairman of Executive Committee.

On motion, the above report of the Executive Committee was ordered received, and spread upon the minutes.

President.—Mr. Berg, acting as assistant secretary, will read a number of letters of invitation that have been received, and also letters from absent members.

Mr. Berg then read letters and telegrams from the following members sending regrets at their inability to be present, and wishing the association a successful meeting, namely, from: H. M. Hall, George W. Andrews, A. C. Davis, C. C. Mallard, C. W. Vandegrift, J. M. Staten, J. F. Mock, R. M. Peck, C. G. Worden, W. B. Mitchell, Floyd Ingram, J. P. Snow.

Also, a letter from Mr. L. K. Spafford, requesting that his name be not considered in connection with the nomination for presidency, owing to his ill health. The letter was referred by the president to the Committee on Nominations.

Letters were read from the mayors of Niagara Falls, N. Y., and Detroit, Mich., inviting the association to hold its next annual convention in their respective cities.

Letters of invitation were then read from Fairbanks, Morse & Co., the American Bridge Works, the Lassig Bridge & Iron Works, and others, extending courtesies to the members during their stay in the city, and requesting the members to call at their respective offices, etc.

Also an invitation from the Western Railway club to take part in the meeting of the club in session at the Auditorium hotel.

The secretary was directed to send suitable acknowledgments in response to the sundry communications read.

Two requests for withdrawal from the association, were referred, on motion, to the Executive Committee for further action and report.

President.—I will ask the chairman of the Local Committee to state what has been arranged for the entertainment of the convention.

Mr. Travis then stated, in brief, what the Local Committee had in view in the way of entertainment, but added that nothing could be arranged definitely until it was known what time the members would have at their disposal to spare. A trip to the Illinois Central shops at Burnside, and also to Pullman, was considered advisable, as well as a visit to the Drainage Canal. As soon as it was decided, however, what time the association would have to spare, the necessary arrangements would be perfected, and the members informed of the same in an official way.

President.—We would like to have an expression of opinion

from different members in regard to these trips. I think it is best for us to complete all business first, and then attend to these outside trips. That has been the judgment of the convention in previous years.

After an expression of opinion by a number of members, it was, on motion, decided to take a trip to the Burnside shops of the Illinois Central Railway, and to Pullman, on Thursday afternoon, and further, to go over the Chicago Drainage Canal on Friday morning.

The convention adjourned at noon, to meet again at 2 p. m.

AFTERNOON SESSION, TUESDAY, OCTOBER 20, 1896.

President.—The first business is the appointment of committees.

The following committees were appointed:

Auditing.—G. W. Hinman, W. B. Yereance, O. H. Andrews.

Nominating.—N. M. Markley, W. O. Eggleston, John Foreman.

Subjects for Discussion.—Onward Bates, M. Riney, N. W. Thompson, G. W. Hinman, G. J. Bishop, W. O. Eggleston, C. M. Large, James McIntyre.

Resolutions.—W. G. Berg, John Foreman, James Stannard, J. O. Olmstead.

Obituary.—J. H. Cummin, O. J. Travis, W. A. McGonagle.

President.—I put my own name on the last-named committee because I am the only one acquainted with our late Brother Graham. These committees will report at the morning session to-morrow, if possible, and, in regard to the committee on subjects for discussion, these names constitute the formal committee. Each member has a perfect right to be present at the meetings of the committee on subjects for discussion, and the chairman of that committee is requested to notify the members when the session of that committee will be held, so that all members having subjects to suggest may be able to present them to the committee.

President.—The next business is reports of committees on the technical subjects assigned last year to the several committees for reports. The first subject is: No. 1.—"How to Determine Size and Capacity of Openings for Waterways." Committee: Aaron S. Markley, J. S. Berry, C. C. Mallard, J. L. White.

Mr. Aaron S. Markley.—Your committee is glad to be able to report progress, but I would ask for a further extension of time, until the next meeting.

President.—What action will you take on the report of your committee?

Carried, that a further extension of time be granted, as requested.

Subject No. 2.—"Different Methods of Numbering Bridges. Should all Waterways be Numbered?" Committee: A. Shane, W. O. Eggleston, J. L. Soisson, O. J. Travis.

President.—Is this committee ready to report?

Mr. Eggleston, in the absence of Mr. Shane, read the report: (See report.)

Subject No. 3.—"Drawbridge Ends, Method of Locking; and under this head include Locking of Turn-tables." Committee: H. M. Hall, James Stannard, H. Middaugh, C. C. Mallard.

Mr. Stannard.—Mr. Hall is chairman and I have not heard from him. I understood, however, that Mr. Mallard was going to send in a report.

Mr. Berg.—There has been received a report on this subject from Mr. C. C. Mallard as follows: (See report.)

Subject No. 4.—"Protection of Trestles from Fire, Including Methods of Construction." Committee: R. M. Peck, T. H. Kelleher, A. McNab, W. M. Noon, G. W. Hinman, William Berry.

President.—Is there any report on this subject?

Mr. Hinman.—I have a report on this subject which I would like to have read. (See report.)

Subject No. 5.—"Local Stations for Small Towns and Villages, giving Plans of Buildings and Platforms." Committee: J. H. Cummin, N. M. Markley, J. H. Markley, C. G. Worden.

Mr. Cummin read the report: (See report.)

Subject No. 6.—"Tanks—Size, Style, and Details of Construction, Including Frost-proof Protection to Tank and Pipes." Committee: W. O. Eggleston, W. M. Noon, A. McNab, N. W. Thompson.

Mr. Eggleston read the report of this committee as follows: (See report.)

Subject No. 7.—"Shearing of Rivets in Plate Girders and Cause thereof." Committee: J. M. Staten, R. L. Heflin, J. H. Travis, G. M. Reid.

President.—Is this committee ready to report?

Mr. J. H. Travis.—I am a member of this committee, but I have not heard from the chairman at all and no action has been taken.

Mr. Berg.—I think possibly it might be well to drop this subject entirely, unless it is considered of sufficient importance to continue it, and I will therefore move, Mr. President, that the committee be discharged. Carried.

Subject No. 8.—"Best and Uniform System of Report Blanks for Bridge and Building Department." Committee: G. J. Bishop, W. O. Eggleston, Onward Bates, M. Riney.

Mr. Bishop read the following report: (See report.)

Subject No. 9.—"Protection of Railroad Structures and Buildings from Fire." Committee: R. M. Peck, L. K. Spafford, B. T. McIver.

President.—Is this committee ready to report? No response being made, the president said that a motion to discharge the committee would be in order.

Mr. Aaron S. Markley.—I move that the committee be discharged, but the subject continued until next meeting.

Mr. Berg.—I think probably the committee should be discharged, but I would also suggest that the new committee on subjects take up the matter and probably they will see fit to report the subject again.

President.—It has been moved that the committee be discharged, but that the subject be suggested to the committee on subjects for discussion at our next convention. Carried.

Subject No. 10 (Brought forward from 1894).—"Mechanical Action and Resultant Effects of Motive Power at High

Speed on Bridges." Committee: G. W. Andrews, W. G. Berg, J. E. Greiner, E. H. R. Green.

Mr. Berg.—The committee on this subject report as follows: (See report.)

Subject No. 11 (Brought forward from 1894).—"Best and most Economical Railway Track Pile-Driver." Committee: J. L. White, A. C. Davis, J. F. Mock, J. T. Carpenter, G. W. Hinman.

President.—Is this committee ready to report?

Mr. Berg.—Mr. G. W. Hinman has requested me to read to the association the following report on this subject. (See report.)

Subject No. 12 (Brought forward from 1894).—"Span Limits for Different Classes of Iron Bridges, and Comparative Merits of Plate Girders and Lattice Bridges for Spans from 50 to 110 Feet." Committee: W. A. McGonagle, R. M. Peck, W. M. Noon, H. E. Gettys, G. J. Bishop, Onward Bates.

President W. A. McGonagle, as chairman of the committee, made a verbal report on this subject: (See report.)

Subject No. 13 (Brought forward from 1894).—"Interlocking Signals." Committee: J. H. Travis, W. S. Danes, R. L. Heflin, J. A. Spangler.

President.—Is there a committee report on this subject?

Mr. Spangler.—I am the only member present of the committee, but I have not taken any action in the matter on account of my having been very busy.

President.—I think this question of interlocking signals is another one of these questions that should be referred to the special engineering department, in charge of that kind of work. We have signal engineers now connected with all the large roads, and while some are members of our association, still the question is one that does not properly come within the scope of our association, and I therefore think a motion to discharge the committee would be in order.

Mr. Cummin.—I think this subject was brought up at least three years ago at our meeting in Philadelphia, by one who was a great deal more interested in signals than bridges and buildings. As the president has said, it seems to me that it is a subject that is entirely foreign to us, as nearly all roads at

this time have signal engineers in charge of this interlocking business, and I therefore move that the subject be dropped, and the committee discharged. Motion carried.

President.—The next business in order is unfinished business, including discussion of reports of the last meeting. The first subject is, "Methods and Special Appliances for Building Temporary Trestles Over Washouts and Burn-outs." This is to be a discussion of the report presented at the New Orleans meeting. We would like to hear discussions from all the members on this subject.

See discussion of this subject participated in by W. G. Berg, G. J. Bishop, W. M. Noon, J. O. Olmstead, W. O. Eggleston, M. Riney, J. H. Travis, and Aaron S. Markley.

President.—Is there any further discussion on this subject? If not, we will proceed to the next subject, namely: "Strength of Various Kinds of Timber Used in Trestles and Bridges, Especially With Reference to Southern Yellow Pine, White Pine, Fir, and Oak."

Mr. A. S. Markley.—This subject is pretty well covered by the report of the committee.

President.—I think the subject has been pretty well exhausted.

Mr. Berg.—I would simply like to make a few remarks and present some information collected on this subject during the past year.

See the discussion of this subject, presenting Mr. Berg's remarks, and a diagram showing strength of yellow pine columns compared with formulas for long columns; also a new formula for timber struts, adopted by Mr. J. E. Greiner.

President.—We will now proceed to the discussion of the subject, "Best Method of Erecting Plate Girder Bridges."

See discussion of this subject, participated in by Aaron S. Markley, M. Riney, G. W. Hinman, A. McNab.

President.—The next subject, "Sand dryers, Elevators, and Methods of Supplying Sand to Engines, Including Buildings," was reported on very fully by the committee last year. If there is any discussion now, we will be pleased to hear it.

See discussion of this subject, participated in by W. G. Berg,

M. Riney, J. H. Cummin, M. M. Garvey, James Stannard, James Rogers, and W. O. Eggleston.

President.—Is there any further discussion on this subject? If not, we will pass on to the next subject, "Best Method of Spanning Openings too Large for Box Culverts, and in Embankments too Low for Arch Culverts."

See discussion of this subject by W. G. Berg.

President.—Is there anything further on this subject? The discussion is closed. The next subject is, "Pumps and Boilers." There ought to be a dissemination of new ideas on this subject.

See discussion of this subject, participated in by O. J. Travis, M. M. Garvey, W. A. McGonagle, James Rogers, N. W. Thompson, James Stannard, Aaron S. Markley, and J. H. Markley.

President.—We will now take up new business.

Mr. Berg.—In accordance with Section 1, Article X, of the constitution of this association, notice is hereby given that I now offer as an amendment to Section 1, Article IV, of the constitution the following:

In the last sentence of Section 1, Article IV, strike out the word "and," and after the word "treasurer," insert the words "and all past presidents of this association, who continue to be members," so that Section 1, Article IV, will read as follows:

"The officers of this association shall be a president, four vice-presidents, a secretary, a treasurer, and six executive members. The executive members, together with the president, secretary, treasurer, and all past presidents of this association who continue to be members shall constitute the Executive Committee."

WALTER G. BERG.

President.—This will lie over for one year. Is there any further new business? If not the convention will stand adjourned until 10 o'clock to-morrow (Wednesday) morning.

Convention adjourned.

SECOND DAY, WEDNESDAY, OCTOBER 21, 1896, MORNING SESSION.

Convention called to order at 10 o'clock.

President.—The next business in order is the discussion of the reports submitted at this convention. The first subject on which a report was made is, "Different Methods of Numbering Bridges. Should All Waterways be Numbered?" This report was read yesterday and discussion is now invited. I hope that all the members will take part in this discussion.

See discussion of this subject, participated in by W. G. Berg, O. H. Andrews, W. A. McGonagle, Onward Bates, A. McNab, J. H. Travis, C. P. Austin, J. H. Cummin, W. S. Danes, W. O. Eggleston, A. J. Kelley, Aaron S. Markley, N. M. Markley, W. M. Noon, J. O. Olmstead, James Stannard, N. W. Thompson, C. M. Large, and M. M. Garvey.

At the conclusion of the direct technical discussion of this subject, the following remarks were made:

Mr. Berg.—I would like to be permitted to draw a few conclusions from the discussion that we have heard in comparison with the report presented by the committee on this subject. The committee reported distinctly in favor of numbering bridges consecutively, and I think that all of us here who have listened to the subject, are fully convinced that the majority of the members present favor the mileage system, which would be in direct opposition to the report. We have heard from a number of members who, while they have to report the system in use under them on their respective roads as being the consecutive system, yet would favor, if they had a choice under new conditions, the mileage system. Our aim, as an association, is not only to spread information in regard to our work among our members and also among the railroad fraternity at large, but we ought to aim to standardize, so to say, the existing practice, or rather to make recommendations as to the best practice, and thus to settle all questions, as far as possible, within our power, which arise in our discussions. Our association has passed the age of infancy, and, I think that we have reached the age entitling us to vote as a body, and I trust that at some future con-

vention, when we are more matured in age, we shall exercise that right and adopt resolutions in the nature of recommendations as a sequel to the reports presented by committees and the discussions following the reports, so that our association will present a finished and general opinion of the majority of the members on the subjects under discussion. I do not care to make a motion for a resolution of that kind at present, because we have not yet adopted that system in our meetings, but I have used this opportunity to call attention to the great desirability thereof, and I hope that at future meetings we shall aim in that direction. In that manner, what we give out then to the railroad fraternity, what we bring to the notice of our superior officers, will be something that is, for the time being, complete and finished, in other words, a concise opinion of the majority of the members present. An outsider or a member of this association, if he has not been here at this meeting, who will get or see a copy of the report of the committee, would be of the opinion, unless he studied the discussion closely, that in this particular instance the practice as recommended by probably a majority of the members of this association would be consecutiveness of numbering, whereas, I think I am right in saying that if a vote were taken we should find that the mileage system would be preferred where a question of choice was possible. I trust I may not be considered presumptuous in making these remarks, but I have embraced the opportunity of calling attention to a very desirable step, that I trust this association will take in the future. I will add that this step will be in perfect harmony with the practice of the similar railroad organizations to ours: namely, the Master Car Builders' association, the Master Mechanics' association, the National Roadmasters' association, the New England Roadmasters' association, and the Railroad Superintendents' association. The purely professional societies, such as the American Society of Civil Engineers, it is true, are very conservative in the matter of resolutions, but such a society is not a proper criterion for our association, as the aims and reasons for our existence are entirely different. We can follow the practice of the railroad associations mentioned without fear.

President.—I think the remarks of Mr. Berg are well timed,

and believe the time is ripe for this association to take definite action on all these subjects. Of course, we will carry out in our railroad work the methods our officers instruct us to use, independent of whether they adopt our recommendations or not, but at the same time, the decision of this association would be valuable to all roads that wish to adopt a uniform system of numbering, and that have not a well-established system already in use.

Mr. Bates.—With all due respect to our worthy president, and the member who has preceded him, I do not believe this discussion is in order, but since I perceive that the remarks have been taken down and may possibly be published, I desire to go on record as being of an entirely contrary opinion. I do not believe that we should attempt to standardize things, or to settle matters ourselves as a body. This is an age of progress. If our bridges and buildings had to be coupled up and interchangeable from one road to another, it would be well enough to have a standard coupler for them; otherwise, I do not see any occasion for this society attempting to establish standards. This is avoided in other technical societies, and I anticipate trouble when we attempt it. Personally, I am not willing to go on record as subscribing to all of the reports which are adopted, and I do not think that our society should be responsible for the opinions of a member or a committee, or even a majority of its members.

President.—The next subject for discussion is, "Drawbridge Ends, Methods of Locking; and Under this Head Include Locking of Turn-tables."

See discussion of this subject, participated in by James Stannard, W. S. Danes, J. H. Cummin, Aaron S. Markley, W. G. Berg, Onward Bates, M. Riney, James McIntyre, J. H. Markley, C. M. Large, W. A. McGonagle, N. M. Markley, N. W. Thompson, James Stannard, W. O. Eggleston, and M. M. Garvey.

Discussion closed, and the convention adjourned until 2 p. m.

AFTERNOON SESSION, WEDNESDAY, OCTOBER 21, 1896.

The convention was called to order at 2 o'clock.

President.—The next subject for discussion is, "Protection of Trestles from Fire, Including Methods of Construction."

See discussion of this subject, participated in by W. O. Eggleston, J. H. Cummin, W. S. Danes, W. M. Noon, Onward Bates, N. M. Markley, G. W. Hinman, G. C. Nutting, W. G. Berg, and G. J. Bishop.

President.—The next subject for discussion is, "Local Stations for Small Towns and Villages, Giving Plans of Buildings and Platforms."

See discussion on this subject, participated in by James Stannard, G. J. Bishop, M. Riney, Onward Bates, J. H. Cummin, Aaron S. Markley, J. H. Travis, Wm. B. Yereance, and W. G. Berg.

President.—The next subject for discussion is, "Tanks, Size, Style and Details of Construction, Including Frost-proof Protection to Tank and Pipes."

See discussion of this subject, participated in by W. A. McGonagle, G. C. Nutting, M. M. Garvey, J. L. Neff, John Foreman, J. H. Markley, C. M. Large, N. W. Thompson, Onward Bates, James McIntyre, Aaron S. Markley, J. H. Cummin, A. McNab, N. W. Thompson, and M. Riney.

President.—We will now proceed to the discussion of the subject, "Best and Uniform System of Report Blanks for Bridge and Building Department." Mr. Bishop, have you received replies from all of the members of the association?

Mr. Bishop.—I do not think I have, Mr. President. I have got replies from about thirty.

President.—This matter has been thoroughly investigated by the committee. I think the report made is complete. I do not think that anything can be added, and we had better pass on to the next subject: namely, "Mechanical Action and Resultant Effects of Motive Power at High Speed on Bridges."

See discussion of this subject, by W. G. Berg.

President.—The next subject for discussion is, "Best and Most Economical Railway Track Pile-driver."

See discussion on this subject, participated in by Aaron S. Markley, N. W. Thompson, W. A. McGonagle, W. O. Eggleston, G. J. Bishop, A. McNab, M. M. Garvey, and J. H. Travis.

President.—This closes the discussion of this year's reports of committees. We will now hear the reports of the committes on auditing, on subjects for report and discussion, on obituary, and on nomination of officers. I will request all the members to rise during the reading of the report on obituary, out of respect to the memory of our deceased members.

REPORT OF AUDITING COMMITTEE.

CHICAGO, ILL., Oct. 21, 1896.

TO THE MEMBERS OF THE ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS:

The auditing committee for the year 1896, report as follows, on the account submitted by the acting treasurer:

DR.

Received from the former treasurer	$210.18	
Received from membership fees and dues	342.00	
Received from advertisements	614.30	
Received from sales of Proceedings	10.24	
		$1,176.72

CR.

Expenses represented by checked vouchers	$848.06	
		848.06
Balance in hand		$328.66

Respectfully submitted,

G. W. HINMAN,
O. H. ANDREWS,
W. B. YERRANCE.
Committee.

REPORT OF COMMITTEE UPON SUBJECTS FOR 1897.

1. Methods of Heating Buildings where three or more Stoves are now Used.
2. The most Suitable Material for Roofs of Buildings of all Kinds.
3. Round House Construction, Including Smoke-jacks and Ventilators.
4. Care of Iron Bridges after Erection.
5. How to Determine Size and Capacity of Openings for Waterways.

6. Protection of Railroad Buildings and other Structures from Fire.
7. Designs for Ice-houses.
8. Best End Construction for Trestles Adjoining Embankments.
9. Bridge Warnings for Low Overhead Structures.
10. Stock Yards and Stock Sheds, Including all Details of Construction.
11. Floor Systems on Bridges, Including Skew Bridges.

Respectfully submitted,
ONWARD BATES,
M. RINEY,
N. W. THOMPSON,
W. O. EGGLESTON.
GEO. J. BISHOP,
C. M. LARGE,
JAS. MCINTYRE,
G. W. HINMAN,
Committee.

REPORT OF COMMITTEE ON OBITUARY.

WHEREAS, It has pleased the Supreme Architect of the Universe to remove from our midst to that Spiritual Building on high, two of our beloved members, Thomas B. Graham and George M. Reid,

Resolved, That in the death of these members our association has suffered a severe loss; the railroad interests have suffered the loss of faithful, competent, and intelligent servants, and the families of our deceased brothers have suffered an irreparable loss and sorrow, which no words of ours can alleviate.

Resolved, That the names of Thomas B. Graham and George M. Reid, be continued on our rolls.

Resolved, That these resolutions be spread upon our minutes, printed in our proceedings, and that a copy, duly attested, be sent to the families of our deceased brothers.

Respectfully,
JOSEPH H. CUMMIN,
O. J. TRAVIS,
W. A. MCGONAGLE.
Committee.

REPORT OF COMMITTEE ON NOMINATIONS FOR OFFICERS.

MR. PRESIDENT, OFFICERS AND MEMBERS OF THE ASSOCIATION OF SUPERINTENDENTS OF BRIDGES AND BUILDINGS:

Your committee on nominations beg leave to offer the following:
President—James Stannard, Wabash R. R.
First Vice-President—Walter G. Berg, L. V. R. R.
Second Vice-President—Jos. H. Cummin, L. I. R. R.
Third Vice-President—Aaron S. Markley, C. & E. I. R. R.
Fourth Vice-President—G. J. Bishop, C. R. I. & P. Ry.
Secretary—S. F. Patterson, B. & M. R. R.
Treasurer—N. W. Thompson, P. F. W. & C. Ry.
Executive Members—W. M. Noon, D., S. S. & A. Ry.; Joseph M. Staten, C. & O. R. R.; W. O. Eggleston, C. & E. R. R.; M. Riney, C. & N. W. Ry.; C. P. Austin, B. & M. R. R.; C. C. Mallard, S. P. R. R.

N. M. MARKLEY,
JOHN FOREMAN,
W. O. EGGLESTON,
Committee.

Mr. J. H. Travis announced that the president of the Santa Fé railroad had arranged for a special car to be put on their regular train on Friday morning, for Lockport, in order that the members might have an opportunity of going to and inspecting the Drainage Canal.

Convention adjourned until ten o'clock, next morning.

THIRD DAY, THURSDAY, OCTOBER 22, 1896.

Morning Session.

The convention was called to order at ten o'clock.

President.—We will receive nominations for the place of holding our next annual convention. The mayors of the city of Niagara Falls, New York, and of Detroit, Mich., have invited us to meet in their respective cities. Are there any other places to be put in nomination?

Mr. Cummin named Denver, Col., and Mr. Hinman named Chattanooga, Tenn.

The nominations were on motion, duly closed, and on a ballot being taken, Denver, Col., was selected for the next meeting place, and so declared by the president.

The next business taken up was the election of officers. There being no additional nominations, the secretary, by the vote of the association, was delegated to cast the ballot of the association for the following officers, who were declared unanimously elected:

President.—James Stannard.
First Vice-President.—Walter G. Berg.
Second Vice-President.—Joseph H. Cummin.
Third Vice-President.—Aaron S. Markley.

Mr. Cummin.—Mr. Bishop has been called out of the room to attend a meeting of the Local Committee, and desired me to say to the association that it would be utterly impossible for him to accept the position of fourth vice-president in any shape, form, or manner,—that he had absolutely declined it.

He mentioned the name of Mr. R. M. Peck as being one eminently qualified to fill the position, and desired me to bring that name before the association.

Mr. Berg.—I regret that Mr. Bishop will not allow his nomination to come before the convention, as I consider he is one of our best members and has shown his ability for work. Under the circumstances, however, I desire to acquiesce in the suggestion thrown out by Mr. Cummin, and second the nomination of Mr. Peck.

The ballot of the association was then cast for Mr. R. M. Peck, who was declared unanimously elected fourth vice-president.

Mr. Walter G. Berg was delegated to cast the ballot of the association for Mr. S. F. Patterson, as secretary of the association.

Mr. Patterson was declared unanimously elected.

The secretary was delegated to cast the ballot of the association for Mr. N. W. Thompson, as treasurer, who was declared unanimously elected.

Mr. Aaron S. Markley.—Inasmuch as I am a member of the Executive Committee and my term has not yet expired, and having received the honor of being elected vice-president, which I very highly appreciate, I hereby resign my position as an executive member.

On the motion of Mr. Berg, duly seconded and carried, the resignation was accepted.

The following members were then elected executive members by ballot of the association: W. O. Eggleston, G. J. Bishop, C. P. Austin, M. Riney.

The president stated that Mr. W. O. Eggleston would fill the place on the executive board vacated by Mr. Aaron S. Markley, so that the executive members for the new year would be as follows: W. O. Eggleston, W. M. Noon, J. M. Staten, G. J. Bishop, C. P. Austin, and M. Riney.

Mr. Berg.—A paper has been received in the form of a letter from one of our members, Mr. C. G. Worden. I would suggest that this be referred to the executive board and those having charge of the publication of our proceedings, to

see how far this paper can be made use of and if it can be embodied in our proceedings, also as to how far the photographs should be reproduced, if found desirable. Seconded and carried.

President.—We will hear the report of the Committee on Resolutions.

Resolved, That the thanks of this association be tendered to the Illinois Central Railroad; to the Atchison, Topeka and Santa Fé Railroad and its president, Mr. E. H. Ripley; to the Pullman Palace Car Company and to the Wagner Palace Car Company for special transportation facilities and courtesies extended the association.

Resolved, That the secretary of this association convey the appreciation and thanks of the members to the mayor of Chicago and his representative, Mr. Dupuy, for their hospitable and kind welcome extended to the association during its stay in Chicago.

Resolved, That the thanks of this association be tendered to the Western Railway Club; to the Sherwin-Williams Company; to the Patterson Sargent Company; and to the management of the Hotel Leland for courtesies extended to the members of the association.

Resolved, That this association desires to acknowledge its appreciation of the large attendance at the convention of representatives of the technical press of the country.

Resolved, That the thanks of this association be tendered to Mr. J. H. Travis, chairman of the local committee on arrangements, for his special services making preparations for this meeting, and also to Messrs. Aaron S. Markley, G. J. Bishop, and O. J. Travis for their valuable assistance.

Resolved, That this association desires to thank all its officers for their efficient management of the business of this association during the past year and the present convention, and further to express its appreciation of the worthy conduct of this convention by its presiding officer, President W. A. McGonagle, assisted by Secretary S. F. Patterson.

Resolved, That this association desires to express its appreciation and thanks to all non-members of this association who have rendered valuable assistance to the various committees in the preparation of their reports; and that the secretary be directed to transmit these resolutions, together with a complimentary copy of the printed proceedings, to all such parties as specified by the chairmen of the several committees.

Resolved, That the members of this association extend to Mr. L. K. Spafford their regrets that he has been obliged to withdraw his name from the list of officers in line for promotion and trust that with improving health he may be able to resume again active work in our association.

WALTER G. BERG,
JAS. STANNARD,
J. O. OLMSTEAD,
JOHN FOREMAN,
Committee on Resolutions.

Mr. A. S. Markley moved that the report be received and made a part of the proceedings. Seconded by Mr. Noon and carried.

Mr. W. G. Berg.—The following letter was received by our last president, Mr. G. W. Andrews, soon after the last convention at New Orleans, from the Hon. J. Sterling Morton, secretary of the United States Agricultural Department, acknowledging the transmittal, by Mr. Andrews, of the resolutions adopted at our last convention, in regard to government timber tests:

Subject: Investigation into properties of wood.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
WASHINGTON, D. C., Nov. 2, 1895.

GEORGE W. ANDREWS, PRESIDENT ASSOCIATION RAILWAY SUPERINTENDENTS, BRIDGES AND BUILDINGS, NEW ORLEANS, LOUISIANA.

DEAR SIR:—I am in receipt of the set of resolutions adopted at the fifth annual convention of the Association of Railway Superintendents, Bridges and Buildings, with reference to the timber test work carried on in the Division of Forestry of this department.

I appreciate fully the interest taken by your association in this work, as coming from men able to judge of its merits. I assure you that I am fully aware of the value of this work, as I have expressed it repeatedly in my reports, and shall endeavor to have the work carried on without interruption, and to its greatest usefulness, as far as appropriations from congress will permit.

Respectfully,
J. STERLING MORTON,
Secretary.

Mr. W. G. Berg.—In this connection, I desire to inform the association of the status of this timber test matter. This association adopted at its last convention at New Orleans a set of resolutions, endorsing the value of the timber tests being conducted by the Forestry Division of the United States Department of Agriculture, and favoring a prompt publication of the test results and suitable government appropriations to allow the work to be prosecuted more quickly and thoroughly. It is very gratifying to record that the step thus taken by this association in October, 1895, has been partly the initiative for other technical and railroad associations to take official action in this matter, and that members of this association have been largely instrumental in urging such action. Resolutions similar to the set adopted by this association, or with the same aim in view, have been passed during the last year by the American Society of Civil Engineers, the American Institute of Archi-

tects, the New York Railroad Club, the Central Railway Club, the Western Railway Club, the Southern and Southwestern Railway Club, the Technical Society of the Pacific Coast, the Engineers' Club of Philadelphia, the Master Car Builders' Association, and others. In addition, favorable action has been taken by associations representing the lumber interests of the country, and also by numerous boards of trade or commerce.

The status of the work of the Forestry Division timber tests is, that out of about 40,000 tests thus far made, the results of only about 2,000 were published, in 1893, while the balance are left unpublished (with exception of some summary data and conclusions in regard to Southern yellow pine, published in a twelve-page circular, in March, 1896) waiting for suitable appropriations to pay for the expense of compiling, editing, and printing the data.

A bill, endeavoring to obtain a suitable appropriation for the continuance of this work, was introduced in the senate on December 27, 1895, by Senator Squire (S. 1214). A similar bill was introduced in the house of representatives on May 6, 1896, by Hon. D. M. Hurley (H. R. 8730). The consideration of these bills was postponed, owing to the attention of congress being devoted to other matters of more interest to the members.

The main trouble seems to be the inability of our representatives in congress to grasp the idea that these tests represent more than a mere hobby of a certain clique of scientists, botanists, or enthusiasts. They regard this work, apparently, as interesting but not necessary; as an ornamental attachment to the work of the Agricultural Department, but not as a prominent factor in the development and economic use of the vast timber resources of this country.

It is needless to call the attention of professional and railroad men to the great value that will accrue to all technical pursuits and industries utilizing timber, to be in possession of more accurate and reliable knowledge as to the physical characteristics and the strength of our principal American structural timbers.

The most important step required to advance this government timber test work permanently might be called an educational one, namely, to convince our representatives in congress that the small appropriation needed yearly to continue this magnificent work is merely nominal, compared with its direct influence and bearing on the large timber interests of the country. In a circular issued this year by the Forestry Division, it is shown that the timber interests of the country are larger than the mining industry, and only second to agriculture.

As above indicated, it is greatly to the credit of this Association of Railway Superintendents of Bridges and Buildings that it has taken an active interest as one of the pioneers in the agitation in this matter.

Mr. A. S. Markley.—In addition to what has been said and offered by Mr. Berg, I would say that if each and every one of us would see our representatives in congress, and call their attention to this matter in our proceedings, a great deal of work would be accomplished and good done in that direction.

President.—The greatest influence that we can exert in this respect is to see the presidents and general managers of the roads in which we are especially interested and have them write our members in congress. I know that a tremendous influence can be exerted in this way.

Mr. J. H. Cummin.—Since our officers have been selected for the ensuing year, I would like to say a few words in regard to one of them, one who I think you will all agree with me has been one of the most faithful officers this association has ever had: I allude to our secretary. I do not wish to interfere in any shape, form, or manner with the duties or prerogatives of the Executive Committee, but I hope the matter of salary of our secretary will not be overlooked, as it could easily be. Our constitution provides that the compensation of the secretary shall be fixed by the executive board, so that I hope the matter will receive that consideration to which it is justly entitled. I doubt but that there are very few members of this association, unless at some time they have had experience in this particular direction, who have the slightest idea as to the amount of work that is thrown on the secretary's hands during

the convention and throughout the year. We may come here and think simply that all the secretary has to do is to look after the minutes; that after he goes home he puts them in the printer's hands, and that there his duty is ended until the next meeting of the convention. But it is far different. I doubt if there is a day in the year but what our secretary receives a communication, if not from some member of the association, from some one outside, in regard to the work and doings of our association. I would, therefore, respectfully suggest that the Executive Committee take this matter into consideration and see if they cannot increase the compensation now paid to our secretary.

Mr. O. Bates.—I feel so much in harmony with the tenor of Mr. Cummin's remarks that I want to second the motion and to explain the nature of the work the secretary has to do. Now I belong to some other associations, and I think in all of them it is admitted that the welfare of the association is more dependent upon the secretary than upon all the other officers combined, as he has always to be at his post, and he has more severe and exacting work from one end of the year to the other, than all the rest. I know of my own case, which I may cite as one in point. I had some matters up with him that I commenced to correspond about several years ago. I was under the impression and supposed that he was properly remunerated for all the information he furnished, as well as the information I asked him to furnish in this particular case. I fell on him and tried to make him responsible for the name of the association. I must say, however, that the correspondence I had with him was extremely satisfactory. When I was away behind with my dues, he was not a bit sharp or exacting, but he managed to collect them before he got through. I have hearty sympathy and admiration for him as an officer of the association.

Mr. Berg.—I think we are all agreed that the compensation of the secretary should be just as large as possible, and in proportion to the large amount of routine work and other miscellaneous work that he has to perform throughout the year, and the only limitation on our wishes will be the amount that the asso-

ciation can see its way clear to pay when the Executive Board considers the financial situation. I trust it will be just as much as possible. I would like to see it as high as the salary of the secretary of the Master Car Builders' association, namely, $3,000 a year, but, gentlemen, until the principles of this association are better known than they now are, and its standing in the community is extended, and until the railroads and the higher officials begin to find out that our voices expressed in convention mean something, we shall hardly get to such a stage of prosperity as this. By aiming, however, in that direction, and getting all our members to help to extend the influence of our association, then some day when we are celebrating our twenty-fifth anniversary, the same as the Master Car Builders did some time ago, we may be just as strong as they are, and then our secretary may get this remuneration of $3,000 per annum.

Mr. A. S. Markley.—I am glad to second the remarks which have been made by the gentlemen who have just preceded me. Very few of us realize the amount of work that is imposed on our secretary. If you would all just glance over our proceedings as they issue from the press, you would see what he has had to do. I hope, therefore, the Executive Committee will take suitable action in the matter.

Mr. Cummin.—The mere getting together of the proceedings is but a small part. I fully agree with Mr. Berg as to the desirability of increasing the salary to the amount mentioned as being paid to the secretary of the M. C. B. association, because if such a thing should happen to pass, I do not know but what I might run in opposition to our secretary some day; however, the secretary of our association and the secretaries of associations of a like character are the mouthpieces of the association to the world at large.

President.—The Executive Committee will take suitable action in this matter, and I hope the suggestion thrown out will not be lost sight of. I am well aware of the work done by our secretary, from the amount of correspondence I have had with him. His work has been complimented by other societies, and I think our proceedings show on their face that the work has been

faithfully done. I know the Executive Committee will take such action as may be necessary. Are there any further remarks on this head?

Mr. Patterson.—I am very much gratified at the confidence expressed in me by the members of the association. I can assure you, it has been my intention to serve you to the best of my ability. I appreciate our good friend Mr. Bates's remarks. We did have a little friendly tilt over the name of our association, and I cordially invited him to come and help to change it, and I see he is here to-day, which pays for the effort in that direction. I feel that my face blushes at the remarks made regarding me to-day; I think possibly they have been a little extravagant, but I appreciate them all the same.

President.—Is there any further miscellaneous business to come before the convention?

No other business remaining to be transacted, the president announced that he would appoint Mr. Walter G. Berg and Mr. Joseph H. Cummin, vice-presidents, to present Mr. James Stannard, the president-elect of the association.

Mr. Stannard having been conducted to, and installed in, the president's chair, Mr. McGonagle, the retiring president, addressed him as follows:

It becomes my pleasing duty, as well as privilege, to induct you into your office, to which you have been chosen by the members of this association. You will find them, as I have found them, the truest and noblest body of men that I have ever been associated with, or that you have been associated with. I hope, in fact know, that they will give you their most cordial support and sympathy. I now present you with this emblem of your authority (handing Mr. Stannard the gavel); receive it and wield it with pleasure to yourself and profit to this association.

Mr. Stannard then addressed the association as follows:

MR. PRESIDENT, OFFICERS AND MEMBERS OF THE ASSOCIATION: I am very sorry that our friend Mr. L. K. Spafford is not present today to take the place to which I have just been elected. About three weeks ago, I received a letter from him, requesting me to call at his office Sunday morning, which I did, and noticed quite a change had taken place and he informed me he was feeling very badly, and at the same time he informed me that it would be impossible, owing to the condition of his health, to be present at our meeting or to accept any office in the gift of the association, as he would leave for Southern California on November 5th.

In looking over the list of officers elect, I find our first vice-president, Mr. Walter G. Berg, who has done so much for our association,

which in my opinion we shall never be able to repay, as he has devoted much of his time to make it a success.

Our second vice-president, Mr. J. H. Cummin, the silver-tongued orator of Long Island, who has always stood ready to respond to any call, and whom I expect we can depend upon to do the talking for our convention for the *coming* year.

Our third vice president, Mr. A. S. Markley, who has always stood ready and willing to assist in any work the association allotted to him and has proved himself a very valuable member.

Last but not least, our good deacon, Mr. S. F. Patterson, who has always shown a disposition to promote the interests of our growing association, using his utmost endeavor thereto, and has cheerfully contributed information whenever asked for, and is highly esteemed by each member.

I believe I shall have the support of all our members, including our ex-presidents, aud in case I should need any assistance in way of information or otherwise, I feel they would only be too glad to contribute.

I am sorry that several of our ex-presidents were unable to be present, as they are very much missed by all. I do not think I have anything further to say to the convention. Thanking each and every member for the honor you have conferred upon me in electing me to the office of president, I shall endeavor to the best of my ability to fill the office to the credit of this association. I wish you all a happy and prosperous year, trusting our lives may be spared to meet at Denver, Col., next October.

President.—Is there any further business to come before the convention?

Mr. McGonagle.—The only suggestion I have to make is in regard to committees' reports. I hope that each member of every committee will commence work the first day after he receives notice of his appointment on the committee. I also hope that he will get such drawings as are necessary to illustrate the point he has in view, and only that portion of the drawings that are necessary so to do.

I hope that the members will either get this information in the form of drawings or in photographs of drawings. The work of tracing drawings that are sent in in the form of blue-prints is becoming such a burden and expense that the work of the secretary is entirely too laborious. The work of photographing or tracing the drawings can be done just as well at the home of each committee member as it can be done at the home of the secretary. The cost of presenting photographs will be very much less than the cost of tracing the blue-prints, and the work of the association will be very much simplified thereby. I hope each member will bear this in mind and send only this information to the chairmen of their different committees. I do not

think it proper that the chairman of any committee should be expected, or even permitted, to make the whole report. I think all of the members of the committee should make it together and should be consulted, and, if possible, the members of every committee, or as many of them as possible, should get together before the report is finally signed. In this way we shall get the best results, and I know that our reports will be much fuller than by having any one member make the whole report.

Mr. Berg.—I desire simply to follow out this idea of our ex-president, Mr. McGonagle, and to give my view as to what a committee's report should be. I consider that when a committee reports on a subject, naturally all the members should work together, and the substance of the report, as far as possible, should deal first with the appliances and methods in use, according to what the question is; then such methods or systems should be analyzed by the committee, giving the *pros* and *cons*, the advantages and disadvantages; and then the committee should draw conclusions in a summary way. If the reports of committees are made in this way, I think they will prove exceptionally valuable.

Mr. Cummin.—I fully agree with our ex-president, Mr. McGonagle, in regard to these reports of committees, especially where plans are furnished. Now if the members would just think a moment that the chairmen of these committees are probably receiving plans from forty or fifty members of the association, and realize the immense amount of work that it is to make drawings of all those plans, and how small the work would be if each member would make a tracing of his own plan and send to the chairman of the committee, it would make a vast difference in the work of this committee. I have gleaned a good deal of experience in this direction during the past year, and I believe out of forty members of this association who sent me plans of stations, there were only two who sent tracings; all the rest were blue-prints. If I had had all of these blue-prints traced off, and cuts made to go into our report, the cost would have amounted to over one thousand dollars. Some of the members were kind enough to send sheets of details showing the method of operation on their system. While all this is

proper and their kindly interest is appreciated, at the same time this association cannot afford to copy or print such plans as those. If the members had simply confined themselves to the selection of one or two stations on their roads and had made a little elevation and plan with figures to suit, it would have saved the association expense and the committee time. I hope our members will think of this, and during next year, if they are called upon to furnish plans, instead of seizing the first blue-print and mailing it off to the chairman, just see if they cannot spare an hour or two and see if they cannot make a tracing and send it to the chairman. I have no doubt but this will be appreciated.

Mr. Aaron S. Markley.—I have had some experience in this matter, but I am sorry to say that I neglected my duty to some extent. It has been the custom for a good many members to rely wholly on the chairmen of the committees to do the work. My idea is for each member when he has the list before him to contribute his knowledge of all these subjects to the chairman of the committee, and by doing so a valuable amount of information can be had and inserted in our proceedings. If all the members, when they receive a circular would furnish this information, it would be very valuable. Any assistance that I can give in this direction during the coming year, I will be very glad to give.

Mr. Yereance.—I would like to bring up two points. As members trace off drawings for submission to committees, it would be much better, provided such will fully serve the purpose, to make simply skeleton sketches, as in the process of reduction to a size desirable for insertion in the proceedings, a plan may be made almost unintelligible in the mass of matter bunched thereon. Referring to the published proceedings of the association, I do not see but we can very well do as the American Society of Civil Engineers do. Their proceedings are issued monthly, in pamphlet form, with paper cover, and if the members wish these pamphlets bound, they can have the work done uniformly and cheaply under a contract the society has with a responsible binder. It does not seem to me the time has yet come when we can afford to issue our proceedings in a substantial binding.

Mr. J. H. Travis, chairman of the local committee, made announcement in regard to the arrangements for the visit of the members in the afternoon to Burnside shops of the Illinois Central railway, and to Pullman, also in regard to the trip for Friday morning to the Chicago Drainage Canal.

The following is the list of committees appointed by the president on the various subjects for report and discussion at the next annual meeting to be held at Denver, Colorado, October 19, 1897:

COMMITTEES ON SUBJECTS FOR REPORT AND DISCUSSION.

No. 1. Methods of Heating Buildings where Three or more Stoves are now Used.

COMMITTEE.

J. H. Cummin, Long Island R. R.
George W. Hinman, L. & N. R. R.
George W. Markley, C., C., C. & St. L. R. R.
William Berry, San Antonio & Arkansas Pass R. R.

No. 2. The Most Suitable Material for Roofs of Buildings of all Kinds.

COMMITTEE.

R. M. Peck, Mo. Pac. & St. L., I. M. & S. R. R.
G. W. Turner, St. L. & San Francisco R. R.
W. M. Noon, Duluth, South Shore & Atlantic R. R.
N. W. Thompson, P., F. W. & C. Ry., Western Div.

No. 3. Round House Construction, Including Smoke-jacks and Ventilators.

COMMITTEE.

George W. Andrews, B. & O. R. R., Philadelphia Div.
O. J. Travis, Elgin, J. & E. Ry.
W. O. Eggleston, C. & Erie R. R.
James T. Carpenter, Lexington, Ky.

No. 4. Care of Iron Bridges after Erection.

COMMITTEE.

James H. Travis, Ill. Cent. Ry.
T. M. Strain, Wabash R. R.
H. M. Hall, Ohio & Miss. Ry.
Walter A. Rogers, C., M. & St. P. R. R.

No. 5. How to determine Size and Capacity of Openings for Waterways.

COMMITTEE.

Walter G. Berg, Lehigh Valley Ry.
Aaron S. Markley, Chicago & Eastern Ill. Ry.
Onward Bates, C., M. & St. P. & M. & N. Ry.
A. J. Kelley, K. C. Belt Ry. Co.

No. 6. Protection of Railroad Buildings and other Structures from Fire.

COMMITTEE.

W. A. McGonagle, Duluth & Iron Range R. R.
M. M. Garvey, Iowa Central R. R.
J. D. Hilderbrand, A., T. & S. F. R. R.
John Foreman, Phila. & Read. R. R.

No. 7. Designs for Ice-houses.

COMMITTEE.

W. B. Yereance, West Shore R. R.
C. M. Large, Erie & Pittsburg R. R.
J. H. Markley, Toledo, Peoria & Western Ry.
George W. Ryan, K. C., F. S. & M. R. R.

No. 8. Best End Construction for Trestles Adjoining Embankments.

COMMITTEE.

C. C. Mallard, So. Pacific Ry.
W. S. Danes, Wabash R. R., Eastern Div.
R. L. Heflin, B. & O. Ry.
A. C. Olney, Charleston, S. C.

No. 9. Bridge Warnings for Low Overhead Structures.

COMMITTEE.

W. E. Harwig, Lehigh Valley Ry.
M. A. Martin, M. K. & T. R. R.
E. H. R. Green, Texas Midland R. R.
Joseph Doll, C., C., C. & St. L. R. R.

No. 10. Stock-yards and Stock Sheds, Including all Details of Construction.

COMMITTEE.

George J. Bishop, C., R. I. & P. Ry.
W. R. Cannon, C., R. I. & P. Ry.
O. H. Andrews, St. Jo. & G. I. & K. C. Ry.
James Brady, C., R. I. & P. Ry.

No. 11. Floor Systems on Bridges, Including Skew Bridges.

COMMITTEE.

B. W. Guppy, B. & M. R. R.
C. P. Austin, B. & M. R. R.
C. W. Gooch, Iowa Central Ry.
F. W. Tanner, Mo. Pacific Ry.

The president announced the following committees on applications for membership and on relief.

COMMITTEE ON APPLICATIONS FOR MEMBERSHIP.

Geo. W. Andrews.
James H. Travis.
C. P. Austin.

SPECIAL COMMITTEE ON RELIEF.

H. M. Hall.
R. M. Peck.
G. W. Hinman.

On motion, the convention was, at noon, declared permanently adjourned.

The next convention will be held in Denver, Colorado, on the third Tuesday in October, 1897.

S. F. PATTERSON,
Secretary.

DISCUSSION OF COMMITTEE REPORTS.

PRESENTED AT THE FIFTH ANNUAL CONVENTION AT NEW ORLEANS, LA., OCTOBER, 1895.

I. Methods and Special Appliances for Building Temporary Trestles Over Washouts and Burn-Outs.

DISCUSSION.

Mr. W. G. Berg.—I will call the attention of the members to the fact that there were two reports last year on this subject, both very valuable and very ably and elaborately prepared by two of our ablest and most experienced members,—one by Mr. R. M. Peck, and the other by Mr. G. J. Bishop. The reports were such that, if I remember correctly, it was stated that no discussion could be had intelligently until the papers had been read over carefully. I trust, therefore, that the discussion to-day may bring out some results. Mr. Bishop, I believe, is here and he can start the subject.

Mr. Bishop.—I do not care to say anything at present on the subject.

President.—The subject is a very important one, and those of our members who have had experience in the protection of trestles from fire, including methods of construction, we shall be very glad to hear from. There are some present who have not contributed to the report of the committee, and from those we would especially like to receive some information.

Mr. Noon.—Mr. President, we have had very little experience in this line, but I might say that we keep a stock of timber on hand for work of this kind, as a protection and safeguard to ourselves. We also keep a certain quantity of timber on hand for re-building bridges burned. In case of a burnout, I look at my records and ascertain the length and height of the bridge, and what material is necessary to re-build it,

and, prepared with that information, I can the more easily attend to it. I get my timber loaded by men most convenient and gather men and material at the burn-out as soon as possible. I arrange to have the section men clear away all rubbish by the time I arrive to start work. I first arrange my men in crews, with a foreman, each foreman to have a distinct section of work to do. The first crew to unload the timber at the most convenient place, and so that he can get at any kind of timber we may want first, and with a push-car will supply us at the bridge as it is wanted. The second crew I start in to make the foundation; if on burnt piles, by cutting them off and putting sills on, or it may be on mud blocks and sills. The third crew, to frame and put together bents ready for raising. The fourth crew to do the raising and bracing. The fifth crew, on top, to put on stringers and ties. We use a 12x12x16 stringer, using the side nearest to 12 in. in depth to save all framing, putting five sticks in one panel and six in the next, and so on, letting the ends pass each other over the caps, then a 8x8x12 tie, using the side nearest to 8 in., so as to save all framing; the only tool work to be done is the squaring off of the posts and a few bolt holes. To keep the ties spaced we use 1 in. strips, the length of the space we want the ties to be, and that nailed to the top of the stringer between the ties. The top crew will lay the rail down as fast as the work advances, and allow the push-car to unload as near the front as possible. I endeavor to equalize the crews as much as I can, by changing off where I see it is necessary and would be to advantage.

President.—Discussion is started, now I would like to see the members rise quickly.

Mr. Olmstead.—We have got quite a number of wooden bridges. We have been fortunate during last year not to have any burned up, but when we do have any burned out, the first thing we do is to start our wrecking gang. They go to a wreck, clean the rubbish out of the way and get everything in readiness for the bridgemen, and my first business is to see that the timber is loaded ready for service. We use 10x10 for posts, and we have lengths up to forty feet. We carry

some in stock for trestles and openings 100 feet. We use 4x12 for sills, raise one post at a time, and brace them, tack on a straight edge and cut off top ends, and put a cap on. We use for stringers, 8x16, with a joint on every other cap. We use a bracing, 3x8, most of the time. Where we have a burn-out not over twenty feet in height, we prefer round timber for posts that we can saw off quickly. These we can handle better. I do not know that I can tell you any more about our method of doing business; that is about the way we get at it.

Mr. Eggleston.—I do not think that I have got much to say. We carry a supply of lumber on hand for this purpose, 12x12 and 12x16x24; and for stringers 12x16. We put on our stringers, and when run out to the end of stringer, put on another. We always do our trestling that way.

Mr. Riney.—I do not believe I can contribute anything more than you have already heard. We use piling for washouts and burn-outs.

President.—There are sometimes different methods of getting at the work, that would be of interest.

Mr. Riney.—We get our material to the bridge site as quickly as possible.

Mr. J. H. Travis.—I do not know that I have anything special to say. There are a few gentlemen here that have had quite an extensive experience with washouts and fires. We had a burn-down a little over a year ago. Two of our truss spans, 150 feet each, burned up over the Iowa river, 75 feet deep; it was quite a little place to go to. We keep the main supply yard, containing all ordinary material, in Chicago, but we have a road market and can always get a sufficient supply to repair 200 or 300 feet of fire or washouts at any time. The system on the Illinois Central is a little different, perhaps, to what it is on other roads. The ordinary repair work on the Illinois Central is under the superintendent. The supervisor of bridges and buildings reports to and receives instructions from the division superintendent, and all ordinary repairs are taken care of by him. In case of fire or washout the Chicago office is immediately notified and we start men, tools, and material from Chicago, and I go myself, no matter

to what portion of the road it is, so as to be there if I can be of any assistance. The first thing that we establish on the road is a good commissary. That is one of the most important things. Men without tools and tools with men without something to eat, are out of place to go to either washouts or to fires. One is as important as the other. We generally provide for a working commissary and take care of our men. If there is work requiring more than twenty-four hours to accomplish, we divide the force into two gangs, working the first as near as we can in daylight. For instance, if we have a week or two weeks' work, we try to get a gang on before daylight in the morning and work them till noon; then we relieve that gang and put on another and work them until nine or ten o'clock at night, allowing all hands then (at whatever point we have reached), to rest on their oars until the next morning a little before daylight. We use in construction, piles and frame bents, fourteen feet centres, 12x14 in., 8x16, four panels, twenty-eight feet long, probably yellow Southern pine. I find that ties like these are quite as long-lived and give as good service as the oak. The ties are only six inches apart and fourteen inches centres. We have very few derailments and when we have, the ties are not cut up much. The last pile-driver that we constructed, to be used in case of emergency, will reach out twenty-six feet from centre to centre, or nearly that. Our standard opening is fourteen feet. If we have a fire where it is possible to drive piling, we do it, reaching out twenty-six feet and putting on eight stringers and driving a bent between that, making it nearly thirteen feet. I believe that is about all I can say on this subject. One thing I would say, however, and it is this: if it is possible to get good bonfires they are a good thing. I keep about three or four carloads of cord wood (or rubbish) cut up into cord wood lengths, where it is easy to load into cars. Where you have to work at night, I find that a bonfire with resin is the best to work with, particularly if you have a side hill. You can work to better advantage and the glare does not affect you.

Mr. A. S. Markley.—In driving piles at washouts, or where water is deep and current strong, it is necessary to have a plat-

form near the edge of the water, where the height of the bridge is ten feet or over above the water, for men to stand on, landing the point of the pile where it is to be driven. To provide for this platform, we use two pieces 3x12, double the length of the openings we are driving; this allows them to extend far enough ahead of the last bent driven to be in easy reach of the next bent to drive. These pieces are suspended from above with lines and back ends anchored down by pieces spiked across the piles on top of the 3x12, as well as nailing to the piles to keep them from swaying. Two pieces of three-inch plank laid crossways of these 3x12, form the scaffold from which the men can work, to set the piles, and if necessary to sway—brace the bents. These pieces are shifted ahead as fast as the driving progresses.

Mr. J. H. Travis.—As to the manner of sawing off piles: In all our drivers we have a scaffold, it is a part of the driver itself, and it slides back on rollers on the side of the car. When ready to drive piles you extend your stringer out, whether it is a 14- or a 16-foot driver. The scaffolding is supported at the outer end by chains to the leads. There is a regular scaffolding hook, made to drop down over stringers. As soon as piles are ready to saw off, there is nothing to do but to drop the hook down for the scaffolding and commence your work. This scaffolding is never taken off the driver. It is with the pile-driver at all times. In regard to the amount of tools that are carried on the pile driver for emergency cases: I have never yet seen too many tools with a bridge gang or on a pile-driver. An emergency is where you need the tools, and a great many of them. You can very easily destroy 500 feet of line in one or two piles. There may be a surplus of flags, but I have seen times when flags were very useful in cases of pinched fingers and cracked feet. (Laughter.) In the majority of cases we use the old-fashioned Howe truss-bridge dogs. You are all familiar with them. They are made generally of 7-8 inch material, to draw the joint of the Howe truss-bridge together, and they are generally long enough so you can drive in the side of the pile and slide a 2x6 inch each way to guide your pile scaffold. There is motion enough so that a man can get out ten feet. You can take off one and push it ahead. If you have

two, or even four bents, and take dogs off after you until you are through, and if the regular dog that you were using is not long enough, make a leg four or four and one-half inches, and put your plank through that. If it is twenty-six feet, instead of using 2x6, you can use 4x8, and make twenty-six feet long, and hang to driver and have a sufficient stay.

A Member.—When you swing up a pile, there is a general pressure against it, if the water is ten or twelve feet deep, or more.

Mr. J. H. Travis.—Your piles must be pulled in position, and before you can get your piles high enough up you will have not more than eighteen inches or two feet, and your plank would be about sixteen feet long, and there would be ample room for going backwards and forwards. I drove piles in thirty-five feet of water on the Grand river. Had no trouble there. I think where you have got only twenty-five feet and are going to drive forty feet, I would just as soon swing the leads and drop the pile out. You can soon catch the point where you want to drop your pile, and I would not want any one at the bottom of it.

Mr. Bishop.—In regard to burn-outs or washouts, the first thing is to ascertain the extent of the burn-out, or washout; its location, and its nature, so as to make repairs accordingly, as in some cases there are different methods in making repairs to same. I have about 500 miles of my territory that is located in eastern Colorado, and western and central Kansas, that are subject to cloud-bursts from about the middle of May until September. Early on the morning of July 3d, 1893, I had a very large washout in western Kansas that took over five days to repair. In the meantime, our trains had to run over other roads, that took them about twelve hours longer to reach their destinations. I had nine distinct washouts, all within eleven miles: five bridges washed out, and four places in the embankment that were from 100 to 350 feet in length, and from sixteen feet to forty-five feet in depth, and I had water to contend with in five of them from ten feet to thirty feet. It was necessary, before trains could cross, to repair and construct 1,680 feet of pile and trestle bridges. My organization was for day and night work. In this washout I had my pile-

driver caught at a station about the centre of the washout, and it was necessary to borrow a pile-driver from another division. At the last bridge that we were driving, and the last pile of the bridge, which was within two feet of being driven, we broke the piston-rod; and that bridge let me get into the station where my pile-driver was. So you can see the importance of carrying duplicate parts of pile-driver engine, in case of an emergency of this kind. August 3d, 1896, in eastern Colorado, I had a side wash twenty-eight feet high, one hundred feet long, where it was necessary to drive one pile to a bent and cap same, and place four stringers under one rail. It was necessary, in addition to track ties, to use five switch ties 7x9x14 to 16 feet long, to support the track, running the ties out on the embankment, and making a floor of trackties, four feet wide, on the same plan as shown for methods of repairing side-wash embankments. It was a success. The soil was a sandy loam, and the stream is very rapid when water is up. In the spring of 1888, across a deep ravine, I had falsework in a bridge that we were about to put iron on, and the masonry was in. The span was sixty feet. During the night we had a very heavy rain, which weakened the structure, and a freight train, during the night, ran across this bridge, ditching fourteen cars and a tank; the engine got across. The banks were very steep and very muddy. We were forty-eight hours cleaning out the wreck to do three hours' work, to get the temporary work in place so trains could cross. In that instance I used up over 1,000 feet of one and one-half inch rope, and broke about six single and double blocks. On my bridge and pile-driver outfits, I carry a large supply of tools of all descriptions, on account of being so far from the storehouse, which carries generally a very small supply, and then in case of emergency we have the tools on hand. For instance, take eastern Colorado and western Kansas. When we have a washout and the line is blocked, we have to make repairs, and that promptly, for after we get 175 miles west from the Missouri river, the company has no parallel lines, and it is necessary to go a roundabout way over some other road. Another thing is, that we have not the markets here, as you have in the East, to draw supplies from, in case of break-

downs. At washouts where there was deep water, I have seen staging break down by some accident and drop all the tools that were on it into the stream. Also, men that work nights lose more or less tools, such as lanterns, bars, wrenches, saws, etc., and when the washout is repaired, I always find there is a large shortage of tools.

II. Strength of Various Kinds of Timber Used in Trestles and Bridges, Especially with Reference to Southern Yellow Pine, White Pine, Fir, and Oak.

DISCUSSION.

Mr. Berg.—As chairman of the committee reporting last year on the subject of "Strength of Bridge and Trestle Timbers," I desire to record some additional data that have come to my notice since the presentation of that report, namely, publications since October, 1895, relating to the strength of timber, and a new straight-line column formula, adopted by one of our members, Mr. J. E. Greiner, engineer of bridges, B. & O. R. R., as also a diagram (Fig. 1) representing the various formulas and results of full-size tests for yellow-pine columns.

In addition, I wish to mention the evident value attributed to this report by the technical press and others, not with a view to calling attention to the personal efforts and work of the members of that committee, but purely as an object lesson to this association, and all its members, illustrating how we are gradually forcing ourselves to the front, and taking the stand that belongs to us by right, in our own particular sphere and line of work among the technical, and railroad associations.

The report was published, more or less in full, by a very large number of the leading technical papers of the country, and briefly noticed in a number of home and foreign journals.

The United States government reprinted the report and all the accompanying tables, as an appendix, in a pamphlet on the "Economical Designing of Timber Trestle Bridges."

The secretary of this association has received numerous requests from individuals for copies, and, personally, I know that college professors, municipal and railroad engineers, have

sent for copies for use in their professional work. It has also been utilized, to my own knowledge, in two of our large cities, where a revision of the building laws has been in progress during the last year.

Mr. F. E. Kidder, the well-known architect of Denver, Col., and author of "Kidder's Pocket Book," has recently published an article on the value of uniform and standard unit stresses for timber, for the use of engineers and architects, especially with a view to establishing greater uniformity in the building laws of our various cities. After referring to the scant data available, consisting mainly of Barlow's "Essay," published in 1817; Hatfield's book on "Transverse Strains," published in 1877, and Trautwine's "Engineer's Pocket Book," Mr. Kidder states as follows:

The most thorough work that has yet been done in this direction is that of the committee on "Strength of Bridge and Trestle Timbers," of the Association of Railway Superintendents of Bridges and Buildings, as evidenced in its report presented at the fifth annual convention of the association, held in New Orleans, October 15 and 16, 1895.

This report is a very exhaustive resumé of all published tests that have been made on American lumber, as well as the recommended values of authors and structural engineers. The report fills forty-nine closely-printed octavo pages, and contains a great mass of valuable information on the subject.

As a result of the investigation of this committee, standard unit stresses were recommended for all varieties of timber used in bridge work at the present day. That these standards will have great weight with engineers, and even if necessary, with the courts, cannot be questioned. As further evidence of an increasing interest in this direction, the report of the proceedings of the twenty-ninth annual convention of the American Institute of Architects contains two very valuable papers on the strength of timber, one by George W. Bullard, of Tacoma, Washington, and the other by Prof. J. B. Johnson, of Washington University, St. Louis.

After comparing the units reported by the committee of this association with other recommended values and the units in existing city building laws, Mr. Kidder continues:

It should be noticed that the values recommended by the railway superintendents and individuals agree, in general, very closely. . . . It would seem that, with the data now available, standard unit stresses might be adopted which would be uniformly recognized throughout the country.

An editorial on the "Working Stresses for Timber Structures," in *The Engineering Record* of November 9, 1895, after a general discussion of the question, concludes as follows:

In view of the preceding considerations, which fail to present in more than outline the actual state of the case, it is a fortunate event for the interest of good timber design that a committee of the American Association of Railway Superintendents of Bridges and Buildings reported to their fifth annual meeting at New Orleans, on October 15, last, a set of ultimate resistances and working stresses, which may at least be considered provisionally justified by such few reliable tests as have been made on full-size columns and beams. This set of quantities, which we printed in our preceding issue, has great value for all architects and engineers, and it should be well considered by them in their timber designs; and for the most part it would not be out of place in the building laws of all large cities. Many of the quantities given are not different from those which well-informed engineers have been using, but it is the best succinct statement of empirical constants for timber of a complete character which has as yet been put forth.

Numerous similar notices could be quoted, not only in regard to this particular report, but also in connection with other reports presented last year, which have been equally favorably criticised and reprinted in the technical press, and extensively utilized for practical railroad work.

The moral of all this is, that we here have direct evidence that the work this association has done in the past is bearing fruit, which is a most gratifying sign. The aims of this association are not only to spread information among our members on the technical subjects we are all interested in, but to disseminate such knowledge throughout the country, so as not only to make improved methods more generally known, but especially so as to standardize the existing practice, and thus obtain uniformity, as far as possible, in the various details of our work.

Publications since October, 1895, *Relating to Strength of Timber.*

Bulletin No. 10, U. S. Department of Agriculture, Division of Forestry, entitled "Timber," being a discussion of the characteristics and properties of wood.

Bulletin No. 12, U. S. Department of Agriculture, Division of Forestry, entitled "Economical Designing of Timber Trestle Bridges." In this pamphlet the report of the committee of the Association of Railway Superintendents of Bridges and Buildings on "Strength of Bridge and Trestle Timbers" is reprinted, together with the accompanying tables.

Circular No. 12, U. S. Department of Agriculture, Division of Forestry, on the "Mechanical and Physical Properties of Southern Pine," published March, 1896, being advance data

and summary conclusions extracted from a comprehensive bulletin on the subject of "Southern Pines," which will be published as soon as the department can do so. The department also has in preparation a bulletin on the "Principles and Practice of Dry Kilns."

Mr. William Hood, chief engineer, Southern Pacific railway, published in *Engineering News* of June 25th, 1896, extensive data in regard to tests of Oregon pine or Douglas fir made under his direction.

The Department of Civil Engineering of the University of California at Berkeley, Cal., has been engaged in extensive tests of Pacific coast timbers during the past year.

The data of all tests of timber made at the Massachusetts Institute of Technology, Boston, Mass., have been republished from the *Technology Quarterly* in a special pamphlet, entitled "Results of Tests Made in the Engineering Laboratories of the Massachusetts Institute of Technology." Address the secretary of the Society of Arts.

The results of comparative tests of Washington fir and Eastern white oak, made by Mr. O. D. Colvin for the Northern Pacific R. R., were published in *Railway Review*, issue of March 7th, 1896.

Notes on white pine timber overloaded in actual use were published in *Railway Review*, issue of March 28, 1896.

Article by F. E. Kidder on "The Proper Unit Stresses for Timber," was published in *The Inland Architect*, issue of August, 1896. The unit values established by the report of the committee of the Association of Railway Superintendents of Bridges and Buildings are very favorably commented on and compared with the values prescribed by building laws in Boston, Buffalo, New York, Brooklyn, and Chicago. This article was republished in *Railway Review*, issue of October 3, 1896.

Notes on the strength of timber by George W. Bullard of Tacoma, Washington, and by Prof. J. B. Johnson of Washington University, St. Louis, are included in the proceedings of the twenty-ninth convention of the American Institute of Architects held last summer, at St. Louis.

Column Formulas for Yellow Pine.

Since the presentation of the report of the committee on "Strength of Bridge and Trestle Timbers" at the New Orleans convention, I have had occasion to prepare a diagram showing various formulas for yellow pine columns in comparison with actual, full-size tests, which diagram was published in the proceedings of the American Society of Civil Engineers. I have prepared a similar diagram, which I present (Fig. 1), embodying the data and formulas mentioned in last year's report, in addition to the straight-line formula adopted last spring by Mr. J. E. Greiner, a member of this association, for the new 1896 issue of the General Specifications for Bridges and Buildings, Baltimore & Ohio Railroad.

Mr. Greiner's formula for yellow pine columns is:

$$\text{Breaking weight} = 5{,}000 - 65\frac{l}{d}$$

For the safe unit stress for columns over seventeen diameters, Mr. Greiner specifies as follows:

Long leaf yellow pine	$1{,}200 - 18\frac{l}{d}$
White oak	$1{,}000 - 15\frac{l}{d}$
White pine	$800 - 12\frac{l}{d}$

where l = length and d = least thickness, all in inches.

Mr. Greiner wrote as follows in regard to his reasons for adopting the above form of formula:

I send you herewith a copy of our 1896 specifications, in which you will find the several unit stresses on timber which, after a mature consideration and examination into the results of all tests made up to date, I have adopted for our regular practice. If you plot the formula for long leaf yellow pine given in these specifications, on the diagram sheet, copy of which you were kind enough to send me, and consider that the formula given in my specifications has a factor of safety of five, you will observe that the unit stresses decrease more rapidly as the values of $\frac{l}{d}$ increase than is indicated by the other formulas plotted. My reasons are:

1. There are but few tests having values of $\frac{l}{d}$ between forty and sixty

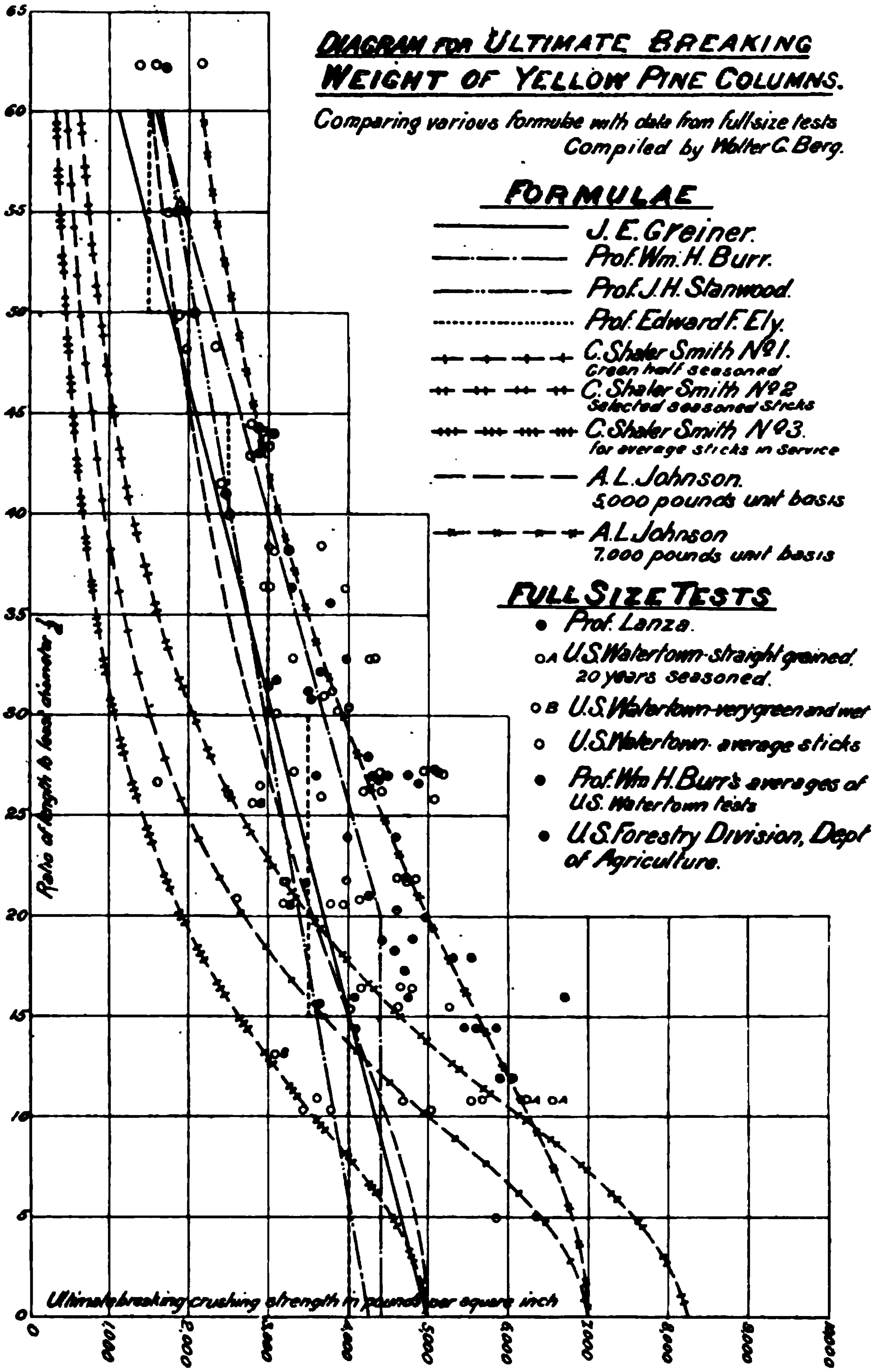


Fig. 1.—Diagram for ultimate breaking weight of Yellow Pine Columns.

as compared with the number between twenty and forty, and these few tests were all more or less selected timber.

2. Timber when used in ordinary service, is almost invariably fresh and unseasoned and, owing to the exposure to the rays of the sun, it is more apt to warp or bend when the values of $\frac{l}{d}$ are greater than forty, than when these values are less than forty.

3. The longer the stick, the greater number of defects it is likely to have.

4. As 1,200 pounds on the extreme fibres is generally recognized as about the right thing for either tension or compression in beams, I consider it advisable to use this same 1,200 pounds as a basis of the column formula.

5. A straight line formula will represent the plotted values of all tests made, just as well as any possible curve will do it, and it is more readily applied.

I hesitated a long time before adopting a formula differing from those already proposed by engineers of recognized standing, but so long as no two of them agree and one more formula will cut no figure, I preferred to add one more, which in my judgment will fulfil practical purposes and is just as good as the others proposed.

III. Best Method of Erecting Plate Girder Bridges.

DISCUSSION.

Mr. Aaron S. Markley.—It is very difficult to outline any certain method to follow in erecting plate girders. There are many different things to be taken into consideration in reference to height, etc. It is almost impossible to decide on anything definite until the location is known. The most practical way, in my estimation, is to erect them on the side of the track; by so doing, a much better job of riveting can be made, and more quickly done. In addition, it takes but little time to slip in place by laying down a couple of rails, and oiling them, and when everything is ready, to slide them in, which is a very short job.

Mr. Riney.—The location is always the most important matter to determine in connection with a matter of this kind. Where the traffic is pretty heavy, we generally handle our work on the outside. Last year, we removed eleven or twelve lattices, and replaced with twelve through floor girder spans in six weeks, and handled on an average eighteen trains in ten hours. There the work was handled from the outside, and temporary trestle work built. The length of the girder will determine, of course, the handling. A heavy girder is better to be handled

from the outside; if for truss work, on the ground of safety, if it is high. If it is a floor system, I would always advise to work it from the outside and bottom, when seventy-five feet or less; for over fifty feet, I would advise building each side of the trestle work.

Mr. Hinman.—Mr. President, I submitted a drawing with my report as to the "Best Method of Erecting Plate Girder Bridges," at our last meeting; that was, by rebuilding them on the outside, and shoving them in place. I know of no better way than this, and no quicker or cheaper way. This is my knowledge and practice. It is very quickly and easily done, and you can get at, and do all of your rivet work, and finish up the bridge complete, except the track rails. The girders can be pulled in place by the use of a tackle and crab. Much depends upon the place where you have to put the girder in. Short girders, say from thirty to sixty feet long, can be erected in the same way, and shoved into place with pinch-bars.

Mr. Markley.—For the benefit of the members, I would say that the Detroit company have built two girders, and in lowering the girders, they were swung right on jibbooms. That is the easiest way I can see, and it struck me as being a very good way, very cheap and very quick.

Mr. McNabb.—How long were the girders?

Mr. Markley.—Fifty feet.

Mr. Riney presented the following description, prepared by him, and previously published in *Engineering News*, of the erection, under his charge, of plate girders across the Wisconsin river, at Merrimac, Wis.

During the erection of the twelve plate girder spans over the Wisconsin river, at Merrimac, Wis., the number of trains that crossed the bridge daily between 7 a. m. and 6 p. m. was eighteen. Work was begun unloading the falsework the last week in September, 1895, and on October 3, 4, and 5, three spans of falsework on both sides of the bridge were raised. On October 5, the iron crew lowered the first girder on to the falsework, and by October 7 the remaining girders and connections for all three spans had been lowered, and the floor beams, laterals, and stringers put in place. On October 9, the first set of girders was moved on to their permanent position. To allow of this shift, the running of trains was so arranged that the time between 2 and 4 p. m. was left free from trains. In making the shift, the first thing done was to remove the ties from the old bridge. A block and tackle was then hitched to the old span, and it was slid bodily out on to the falsework, by means of a hoisting engine. The time occupied

in doing this was three minutes. The hitches were then changed to the new girder span, blocking meanwhile being placed on the towers to provide for the less depth of the girder span. The new span was then slid into place in about five minutes. The old span was moved about fourteen feet, and the new span about fifteen feet, from their original positions. Before starting to move the new span, the ties had been placed so that all that remained to be done was to put the rails into place. The procedure with the remaining spans was exactly similar, and the following statement shows the time occupied in placing each new span complete:

No. span.	Hrs.	Mins.	No. span.	Hrs.	Mins.
1	2	30	7	1	10
2	2	00	8	1	30
3	2	05	9	1	40
4	1	15	10	1	30
5	2	00	11	1	40
6	1	45	12	1	30

Only one train was delayed, and that during the change of the first span, when the men were new to the work, and over-careful.

When the three new spans had been set, the next task was to remove the old spans, so as to get at the falsework to move it to a new position. Two long pine timbers were placed on timber horses transversely across the car, with their ends overhanging on each side of the bridge. By means of block and tackle, operated by a hoisting engine, also on the car, two bents of the falsework on each side of the bridge were picked up, and the cars moved along the bridge to the points where the bents were to be set again. Everything possible was handled by a locomotive, hoisting engines, and a wrecking car. The first span was set in place October 9, and the last, October 31.

Mr. C. G. Worden forwarded the following written discussion:

I send some photographic views (Figs. 2 and 3) of a riveted deck girder bridge, 710 feet long, and 56 feet high; consisting of seven 80-feet, one 60-feet, and three 30-feet sections, that I have recently erected for the Southern California Railway company. This bridge is across the Arroyo Seco, on the main line of the Southern California Railway, between San Bernardino and Los Angeles. On this division, we have twenty-two trains between 7 o'clock a. m., and 6 o'clock p. m.

Previous to the erection of this structure, the company had imported men from the East to place their iron and steel bridges; this one, however, has been done by men in the regular employ of the company, and at a price so much less than such work has cost them heretofore, and so much less than bids received for this one, that I feel some pride in placing these before the association, thinking at the same time that they may give some new ideas to the members of the association who may hereafter have occasion to erect a similar one. The management had some hesitancy in having this work done here, as they thought it impossible to secure the men competent to do the work, all

FIG. 2.—Rebuilding Arroyo Seco River Trestle Bridge, Southern California Railway.

of our bridges except two being of wood, and ninety-five per cent. of them pile and timber trestles. After looking over my estimates, and finding a difference in their favor between that and the contractor's, they concluded to do the work with their regular employees.

I had at first intended to lower these girders into place with hydraulic jacks. However, owing to the situation, I found it necessary to have some conveniences for setting the pedestal stone and posts in bents, so I concluded to use two travelers with suitable tackle instead. While the excavations were going on, I put in my falsework (the original bridge consisted of 525 feet of timber trestle, and two—105 feet over all—overhead Howe truss spans, altogether 735 feet); by trestling the two spans, and cutting out a section twelve inches long of the posts of trestle part, and introducing an intermediate cap, a distance of twelve feet below the rail to form lookouts for track for travelers. In this way, my falsework was very inexpensive, and gave me a chance to place everything from the top, using one traveler for placing the pedestal stones the entire length, and placing the posts on return trip. After the posts were placed, another traveler was erected, in order to carry both ends of the girders.

The only suitable place for an unloading and erecting yard was 2,000 feet south of the Arroyo; consequently, everything had to be sent out on push-cars that distance, except the girders, which were loaded on trucks and moved with a locomotive. The girders were riveted together on the skids, the ties, tie-plates, guard-rail, and rail placed on them, then loaded on the trucks ready to be sent out. When they were spotted over their place, jacks were put under each end, and they were raised clear of the trucks; then the tackle was hitched to them, a strain taken, the trucks run out, jacks released, and they swung clear. Owing to the height, the stringers-ties and guard-rail of the old bridge had to be taken on deck. The bents were let down on the intermediate caps, then the girders were lowered into place by means of the lines. We were enabled to swing the girders either way, so that when they were within six inches of their seat, we inserted a small, pointed bar at each end which guided them into place.

In placing the first girder, we of course took advantage of the longest time between trains, two hours and fifteen minutes; we consumed all that, and seven minutes of train No. one's time. The men, sixteen, were all new; only one of the lot had had any previous experience, and they were a little timid, for the weight of these eighty feet girders, with ties, etc., is forty-seven tons.

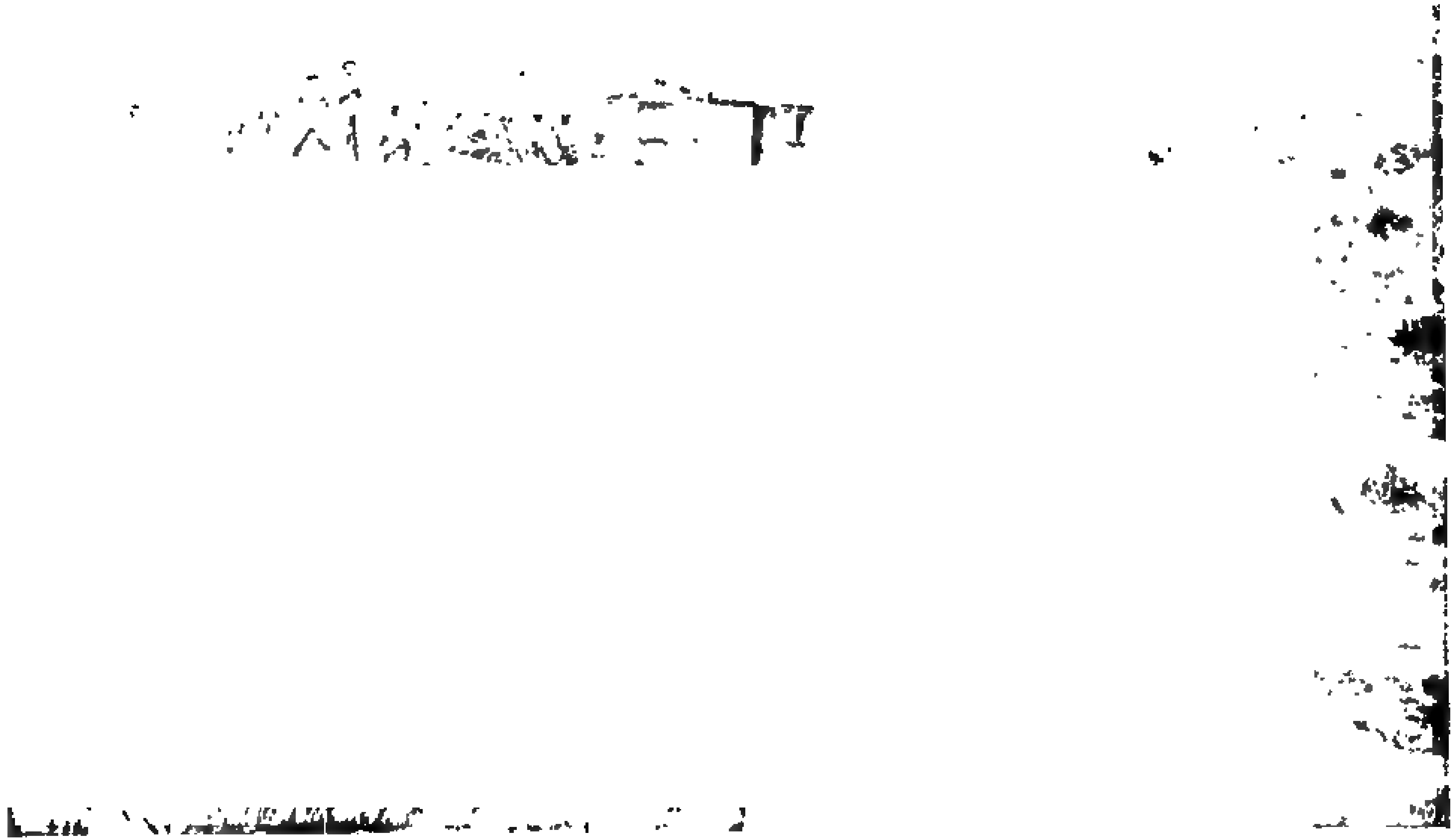


FIG. 8.—New Iron Trestle Bridge, Arroyo Seco River, Southern California Railway.

The next day, however, the second eighty-foot girder was placed in one hour and thirty-eight minutes, and when we placed the one shown in the photograph, it was done in fifty-eight minutes, from the time it was spotted until the girder was in place and bolts in, or one hour and eighteen minutes from the time it left the spur, until the attending locomotive passed over it.

The cost of placing these eleven girders, together with the riveting, unloading steel, loading on trucks, engine attendance, etc., was $1,255.49, or $1.7683 per lin. foot.

The cost of placing the four rocker, and three tower bents was, $570.04, or $0.8003 per lin. foot.

The total cost of superstructure, including falsework and traveler, was, $2,248.85, or $3.1674 per lin. foot.

Riveting girder, drove	8,026,	cost, $0.05024	per rivet.
Riveting bents, drove	480,	cost, $0.1066	per rivet.
Riveting girders to posts	264,	cost, $0.1458	per rivet.
Total rivets drove	8770,	cost, $0.0573	per rivet.

IV. Sand-Dryers, Elevators, and Methods of Supplying Sand to Engines, Including Buildings.

DISCUSSION.

Mr. Berg.—I would like to refer to the more extensive use that is being made daily of compressed air in moving sand in connection with supplying sand to locomotives. It is quite marked, and a large number of novel devices and expensive plants have been adopted within the last few years. I have recently heard of a novel construction on the Chicago & North Western Railway, I believe either here in Chicago or right close to it. The idea for taking sand is similar to that for taking water; in other words, it is a sand stand-pipe. The sand house is located conveniently several hundred feet away, and the dry sand moved by compressed air to this stand-pipe with a horizontal pipe swung out over the track. This is certainly a novel construction, and indicates the general trend in the matter of moving sand for locomotive supply, especially where compressed air is easily obtainable.

I believe thoroughly in all these improved methods, that is, where there is a plant of sufficient size to warrant a regular force of men to be engaged in the business; but for a small plant with intermittent service, where the crew of an engine has

ample time to get off and load the sand, I am a very strong advocate of the good, old-fashioned, cast-iron, sand-dry stove, which can be so located that it does not require a special man to look after it, as one man can look after other duties in the same neighborhood, such as attending to a coaling station, oil house, roundhouse, etc., and attend to the sand stove at the same time also. I think that the introduction of complicated and expensive sand-drying appliances is possibly in some cases a fad adopted by railroad officials but not warranted if the small output of sand is considered. In other words, I thoroughly believe in improvements and labor-saving devices, but deprecate the introduction and duplication of expensive plants, even in a modified form, at small stations. For these, I still believe, as I said before, in the good, old-fashioned, sand-drying stove.

President.—We ought to have some members here with some ideas on this subject that have not been expressed here in previous years. I would like to ask Mr. Riney what his experience is, and what he has in operation.

Mr. Riney.—We have in use the old-fashioned, cast-iron, sand-drying stove. We were talking of getting a new device, but I do not know that we shall get it. We take care of some ninety engines in twenty-four hours with the appliance we now have.

Mr. Cummin.—I would like to postpone anything I have to say on this question until next year. We are now in the middle of a large job, coaling station and sand-drying building and appliances, and I shall be able to give this association full particulars and description, and everything in regard to it, by that time.

Mr. Garvey.—I am very much interested in that matter, and shall not have a chance to wait until Mr. Cummin can make a report. I can tell you what we are doing, and then I would like to hear from the other members to see if they have not some plan. We have got a sand-dryer and pump, and are going to fill up the sand-dryer, and load the sand on the cars run up to our coal-chutes, just the same as coal, and we have arranged to fix two of our coal pockets for sand tanks, putting up a

spout, and when engines take coal, they will take sand at the same time.

Mr. James Stannard.—We use an elevated sand house which is located on elevated coal track at end of chutes. Cars of green sand are placed on end of elevated coal-chute tracks and unloaded with shovels from cars into sand house. Our mode of drying is by use of large, cast furnace, somewhat in shape of a stove with a hopper made of heavy wire netting. Hopper is kept filled with green sand, which is passed in at top by use of shovels. We use coal for fuel in above furnace. Sand screen is placed between sand dryer and dry sand bin, through which dry sand is passed from sand dryer to bin. Sand-bin is made in shape of hopper with valve located at lowest point, from which sand is passed through spout to sand dome on engine, on the same principle as water is taken from water-tank. Capacity of dry sand-hopper, about two carloads or twenty-four cubic yards. Time required for sanding engine, about two minutes. Capacity of green sand storage as per blue-print, is about seven carloads or eighty-four cubic yards. Man in charge of coal chute also has charge of sand drying. Cost per yard for handling and drying sand, about twenty-five cents per cubic yard. I consider same a very convenient, economical method of handling sand, there being no waste in handling.

Mr. Berg.—As I understand it, Mr. Garvey would like to get some information at the present time on this question, and I would therefore refer him to the very able report of the committee, embodied in our last year's proceedings, of which committee Mr. Aaron S. Markley was chairman. I think that that report and last year's discussion of the subject, taken in conjunction with articles in the technical press of the country, will certainly give him a great deal of information.

Mr. Rogers.—We have a plant at Stoney Island for drying sand and elevating it into a small tank. It is used for drying sand, and pumping air through an air chamber, and getting water for washing out in the round house, and the apparatus is equipped with a hopper and a sand bin alongside the boiler and the sand is thrown up and run down into a reservoir, and under this there is an air tank which blows the dry sand up

into the tank outside, contiguous to the track where the engines come from the roundhouse, and it is run into the engine from that tank the same as water. This arrangement that I speak of is at Stoney Island, and I would be very glad to take anybody down there that wants to see it and is interested in it.

President.—If any one has any new ideas on this subject, we would be glad to hear from him. Mr. Eggleston, have you got something to say?

Mr. Eggleston.—We have two on the Chicago and Erie; one is referred to and illustrated in our last proceedings, and is a success. Since that time, we have put in one at Chicago and it can be seen in operation any day. Engines coming out of the house take sand the same as water. The work is all handled by the man in charge of the engines. The sand is put into the dryer and then carried up by air pressure. This is located at 49th St., and I would be glad to have any of you gentlemen see it work at any time.

V. Best Method of Spanning Openings too Large for Box Culverts, and in Embankments too Low for Arch Culverts.

DISCUSSION.

Mr. W. G. Berg.—Mr. President, I can only repeat practically what I said last year on this question, that, in my opinion, it is very desirable to obtain a continuous road-bed, and, therefore, the method reported on by the committee last year, of which Mr. James Stannard was chairman, was a very efficient and good construction. It consisted of a ballasted road-bed on top of old rails or old girders placed close. I further might emphasize the desirability, in many cases, of spanning such openings during the first construction of the road with ordinary timber trestle bents, which can be replaced at the proper time with the permanent construction mentioned. In the discussion last year, if I remember correctly, the question at one time involved seemed to have been whether it was desirable to have a closed culvert based on the plan as reported by the committee, namely, ballast on old rails or girders, or whether to have a

regular permanent stone and iron span. I can only say that I believe it is advantageous every time to do away with the additional opening in the road-bed and that, therefore, wherever the finances of a road will permit it, it is desirable to have low, wide openings spanned with the ballasted road-bed on an old rail or old girder floor.

President.—The matter was well discussed last year, and the committtee report was very complete.

VI. Pumps and Boilers.

DISCUSSION.

Mr. O. J. Travis.—I think the subject was pretty well exhausted last year, and I do not think I can add anything.

Mr. M. M. Garvey.—I use a good many of them, but I do not know that I can tell the members anything new. In Iowa, we are trying to get rid of our old windmills and put in pumps and boilers. We adapt ourselves to the occasion when we can, and use boilers. We consider them a good deal cheaper than to depend on the wind. On our road one man has got two boilers to look after, and we are now getting so we are having very good satisfaction, except in places where we have been trying to use city water taken from a long distance under the ground, and that we could not use in the boilers. We tried two or three places and had to give it up. For the past two years, we have had no rain in Iowa until this year. We are now in good shape, and have got our pumps loçated at places where there is no difficulty. I do not know that there is anything new that I can enlighten the members upon.

President.—Do you use single or duplex?

Mr. Garvey.—We use duplex.

President.—We ought to have some information on this question of duplex pumps. There is a difference of opinion between manufacturer and superintendents as to which is the most economical. I would like to have an expression of opinion from quite a number of our members.

Mr. Rogers.—I could not tell anything new about them. We have a good many, but they are all old.

President.—The point we want to get at, is an expression of opinion as to the economy of duplex versus single pumps.

Mr. Thompson.—I could not tell anything about the duplex. We use the single and it gives very good satisfaction.

Mr. Rogers, in answer to Mr. Markley as to the quantity of water pumped per hour, stated that they pumped twelve thousand gallons.

Mr. Stannard.—We use single pumps and find they give very good satisfaction. There is one thing about it, we turn our exhaust into the discharge pipe, which we find is a good thing.

Mr. Markley.—Does not Mr. Stannard mean suction-pipe?

Mr. Stannard.—Yes.

Mr. Aaron S. Markley.—During the past year, we have connected nearly all of our exhaust-pipes from the pump into the suction pipe sixteen feet from the pump with a Y connection, the Y, of course, leading toward the pump so the force of the exhaust will aid the pump in lifting the water. We find from a number of tests made, that this increases the temperature of the water from six to eight degrees, thus preventing the water from freezing in the tanks, and saves fuel in locomotives. In putting these exhausts into the suction-pipe, care should be taken that all joints are air-tight, and valve-stems, if any, are well packed to prevent leaking air. We have them on both duplex and single acting pumps, both of which give good satisfaction connected in this manner. In making these connections, we arrange them so the exhaust can be turned out in the open air if so desired, or into the suction-pipe.

Mr. J. H. Markley.—We are using the duplex, the Worthington and the Knowles single pump. We like the duplex every time. The Knowles takes from seventy-five to eighty pounds of steam pressure, and the Worthington from forty to forty-five pounds with the same result.

Mr. Markley.—What effect has it on the water running into the discharge?

Mr. Stannard.—It heats the water and warms the cylinder.

Mr. Markley.—In that case you would have to drain your discharge pipe every night.

Mr. Stannard.—Yes.

Mr. Markley.—What arrangement is there for keeping the water from running back?

Mr. Stannard.—The water pipes through the tank, and the exhaust-pipes through the discharge.

Mr. Markley.—It looks to me that that would create a back pressure on the pump.

COMMITTEE REPORTS.

I. Different Methods of Numbering Bridges. Should all Waterways be Numbered?

REPORT OF COMMITTEE.

To the President and Members of the Association of Railroad Superintendents of Bridges and Buildings.

Gentlemen:—Your committee on different methods of numbering bridges, and "Should all Water-ways be Numbered?" beg leave to submit the following:

The art of successfully managing the Department of Bridges and Buildings can only be acquired by a thorough education. Those of us who have not had the advantage of a college education must be content with a practical one, and as it is impossible to rehearse our lessons, but as we are pressed on by rush of business from one to another, it behooves us to put ourselves in a position to refer to our past from time to time as occasion may require, and not only freshen our memories, but furnish beyond doubt reliable data.

This can only be done by the aid of a thorough and systematic record of all work, both great and small, not omitting the slightest detail. Until one begins to inquire into such matters, he little dreams to what an extent we have become remiss in this respect.

We quote from bulletin No. 12 of the division of forestry of the United States Department of Agriculture, in treating upon the economical designing of timbers in trestles. Mr. A. L. Johnson says: "Table 1 gives the different species now employed in various parts of these structures, and a mean estimate of the length of life of each. These separate estimates, however, were very erratic, in many cases being little better than a guess, so that the mean given in the table is by no means reliable. This lack of information is scarcely less remarkable than it is unfortunate. Although railroad companies have been using timber for more than fifty years, no accurate, classified knowledge exists as to its length of life. This could be easily obtained if each member in a trestle was given a number, as is done in iron structures. Thus we find that practical men have been using timber for fifty years, and yet, when called upon, could give no reliable information as to its longevity This is not from a lack of knowledge, but is owing to the fact that no records had been kept.

As with timbers, so with each and every other material used in the construction of water-ways of every dimension. We should keep a record of the cost of all such material, and the labor performed on each structure, date of construction or renewals of whatever nature and extent. A knowledge of these things is a component part of a practical education, and once acquired should be perpetuated. We cannot expect to retain this knowledge and be always ready without a moment's warning to answer any question that may be asked, or decide upon any point at issue, or give any information wanted, except approximately, which will not at all times be satisfactory.

In an article on substitutes for a college training, the Rev. Charles H. Parkhurst, D. D., says: "I studied Greek faithfully when I was in college, and read considerable of Homer, but I do not suppose I could read a line of him to-day without a grammar and dictionary. If anybody says I ought to be ashamed of it, all I can say in reply is, that I am not ashamed of it at all. When a traveller comes to a river, he looks about to find a bridge by which he can cross it, and when he gets to the other side of the bridge he leaves it for the next man with-

out its ever occurring to him to take it along with him. So when a mountaineer is scaling the sharp spur, and finds a ladder spiked in for the convenience of climbers, he puts his foot upon it, scrambles up over it, and then leaves it behind him, never expecting to encounter any one who is so much of a fool as to rebuke him for not having trummeled the ladder up with him, and for not having capped the summit with all his mountaineering paraphernalia. What I mean by this is that Greek, Latin, physics, and mathematics are primarily not the goal of pursuit, but the bridges, ladders, and other apparatus for locomotion by which the goal is to be reached. So that whether we do or do not know how to read Plato and Livy six years after we are out of college, or how to analyze Homer and calculate ellipses, we are still at the apex if we are possessed of the mental keenness and vigor which it is the special office of those studies to produce." And farther on he says: "Problems tumble easily apart in the field, that refuse to give up their secret in the study, or even in the closet. Reality is what educates us, and reality never comes so close to us with all its powers of discipline as when we encounter it in action."

Then let our records be our grammar and dictionary to practical work, and their correctness a source of reliable data, and if not a guide our successors can follow, they will at least serve as a beacon to protect them from the breaker. We should also keep a record of our work, that we may be able to give an account of our stewardship. Show where all the money has been expended in detail, and not deal in generalities, for that is no longer satisfactory to officials of railroads, and if there should be an occasional official satisfied, the superintendent of bridges and buildings should not be. In order to keep such a system of accounts, it is necessary to be able to designate each structure in some manner. This may be done by describing structure and location, by naming, or lettering. The general practice, however, seems to be numbers.

Your committee has inquired as to the methods adopted by different roads, a few of which we submit as a part of the report.

Mr. J. M. Staten of the C. & O. furnishes us with tracing No. 5,604, and writes: "We only put numbers on openings ten feet and over. Never number anything like box or arch culverts, no matter what their length may be. You will observe that number blocks have numbers on each side, which is the same from each direction. Ten bridges may be on the one mile, and if one of these should be dispensed with it will not affect the remainder, or if a new opening be created on the mile, the fraction of a mile numbers it. This is a big advantage over the old conventional way of numbering. Do n't know the actual cost of number blocks, but they are very inexpensive. I must emphatically denounce numbering all waterways. This seems utterly useless to me. All railroads are endeavoring to fill up all openings less than ten feet by using old iron and scraps of steel rails, and ballasting over them so they are then looked after by the section men.

Mr. F. E. Shall, assistant engineer L. V. R. R., furnishes us with blue print No. 44, and says: "The method adopted (although not yet carried out), is as follows: The bridges are to be numbered in accordance with the mile on which they are located. For instance, the bridges located between the first and second mile post, the first would be No. 1, the second No. 1A, the third No. 1B, and so on. The bridges between mile posts 50 and 51 to be 50A, 50B, 50C, etc. For box and arch culverts, it is our intention to use the same numbering, but to place a cipher in front of the number. The bridges on branches are to be numbered in the same manner, but to have the first letter of the name of the division placed in front of the number. Through bridges are numbered on the end post, while deck

bridges are numbered on a sign post made of three-inch oak plank. A copy of the post I send you herewith."

The Chicago & Erie Railroad Co. furnishes us blue print 34, showing structure number, and 35 and 36, copies of bridge sheets. This road has a number plate of 1-8 steel tank plate, old material, 7 x 12 inches, with a 5½ block figure on posts of 3-4 or 7-8 iron rods. Number plates painted black with white figure. Drill a hole in parapet 4 feet from end of this and set number with cement on pile trestle. They set it in bulk heads; at over-head bridges they set a post and put number plates on it. Truss bridges are numbered by painting number on both posts. On through girder, they paint the number on end girder. The numbers on through bridges are on engineer's side on both ends of the bridge. The numbers for deck bridges have figures on both sides, and only one number for a bridge. These number plates cost 38½ cents each in position. They also keep a record of all bridges, showing the number of the mile post, description of structure, length, foundation, date of construction, name of stream, if any, if box and pipe water-ways showing size, kind and location by mile posts and 1-4 mile; but their small openings are not numbered.

The Elgin, Joliet & Eastern number all openings consecutively on an oak board 2 x 12 x 18 inches, with a white ground and black figure, the figure being 3 x 3 inches. One of these boards is fastened to the cap at each end of trestle with lag screws, and always on the engineer's side. This style, while not so artistic as some methods, is considered by those people to be the most economical, and its simplicity recommends it. As these numbers were put on by contractors, the original cost cannot be given. The road has been built for eight years, and not a single number has been renewed.

Tracings No. 24 and No. 243 show number plate used in the entire system of C., C., C. & St. L. This road numbers all structures of every kind consecutively. They keep a record of all bridges and culverts as shown on bridge sheet No. 1, and open an account with each structure, recording all material that enters into its construction, describing the same, giving date and extent of all repairs, and cost of labor.

There are a number of other methods used for numbering structures, and a diversity of opinions as to whether all openings should be numbered. The majority of roads number consecutively, some using the affix letter where the same stream crosses more than one track. For instance, structure No. 28 is on the main track; on the next track to the main the same structure would be 28A, and if there be another track over the same stream at the same point, it would be 28B, etc.

There are a few roads that pay but little attention to the numbering of structures, being content to make a general charge of expense to bridges and culverts. But should this method be satisfactory to the company, it should not be to the superintendent of bridges and buildings, for a systematic numbering of structures and records will serve him at a time when he will most need it, in furnishing valuable data as to the durability of material, cost of construction; refreshing his memory; and to himself and successor it will be found a source of valuable information.

The committee that made a report October, 1895, on "Methods and Special Appliances for Building Temporary Trestles over a Washout or Burnout," recommends, first, when a washout or burnout occurs, the first information necessary is the definite location of break in the track. The next question for consideration is the kind of structure which is washed or burned out, whether it be a trestle or truss bridge, length of structure, depth of opening, characteristics of stream, as to whether there is likely to be water, mud, or sand to con-

tend with. The superintendent of bridges and buildings should have the above information on file in his office, in order to enable him to determine, to a great extent, what kind and manner of temporary work will best meet this requirement. This being done, simply wiring number of structure, and reference to those records will give all required information.

Your committee, in selecting sheet No. 1 of the C., C., C. & St. L., has purposely taken one that has not been posted up since 1891. This we have done to show the advantage of keeping a complete official record in addition to the bridge sheet. By referring to the sheet you will notice the first structure, 499, is a trestle 42 feet long. By referring to the books we find that in 1894 the opening was filled up at a cost of $54, and the structure abandoned. In such cases the number is taken off. The next structure on the sheet is a combination truss built in 1882, and is 128 feet, 4 inches long. By referring to the books we find that this structure was rebuilt in January and February, 1896. The cost of masonry was $11,412.62, including excavating; contract price for girder No. 139,220 at $18, $2,505.96; false work, $316.20; labor, dismantling old bridge, raising track to new grade, unloading and putting in two 75 ft. girders, $812.28; total, $15,047.06; and this structure now consists of two 75 ft. girders, with a clear span of 70 feet each.

The next structure to which we will call your attention is No. 518. Sheet shows this to be a wood box 24 x 36. Reference to the book shows that it was reconstructed in 1893, and is now a 48 inch cast pipe 48 feet long, with masonry at each end, at a cost of $831.28.

We would further call your attention to the fact that location of structure is shown between mile posts, and also stations. The difference between it and sheet of Chicago & Erie R. R. is that they show fraction of a mile, and not the station. We failed to state, the cost of C., C., C. & St. L. structure numbers complete is 27½ cents, and as numbers are on both sides, only one is placed at the approach of each structure, on engineer's side, six feet from the rail.

We have endeavored to show the necessity of keeping a record, and the advantage it affords in refreshing our memories, enabling us to account for all our expenditures, and furnish reliable data as to the longevity of all material, and that to do this it is absolutely necessary to be able to designate each structure, and by including every kind of structure a more general knowledge can be had.

Your committee recommends consecutiveness and simplicity of numbering, for by that method the number itself becomes an index to your book. Be careful in keeping records correct, for they will be your guide, and that of your successor, and you will not have to depend on a treacherous memory to retain knowledge gained by a lifetime of practical work.

We are told that Franklin kept a book in which he wrote down his faults. If he wasted half an hour of time, or a shilling of money, or said anything he had better not have said, he wrote it down in his book. He carried that book in his pocket all his life, and he studied it as a boy at school studies a hard lesson. By it he learned three things—first, to do the right thing; next, to do it at the right time; and last of all, to do it in the right way.

If Franklin could not trust his memory to correct the mistakes of his life, can we be expected to retain all the transactions incident to a business life, although it is a part of our education, a work that is not finished while we live?

A. Shane,
W. O. Eggleston,
O. J. Travis,
Committee.

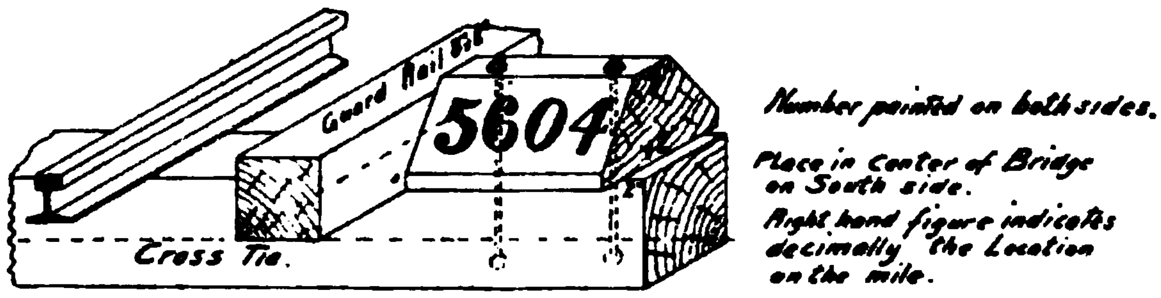


FIG. 4.—Bridge Number, Chesapeake and Ohio Railway.

DISCUSSION.

Mr. W. G. Berg.—This question seems to have been divided by the report of the committee into two questions, one as to how to number and the other whether all openings should be numbered. In regard to the first question, how to number bridges, the committee report is in favor of consecutiveness, that is, numbering the bridges from one end of the line to the other with consecutive numbers. The committee report also mentions the mileage system of notation, in use on a number of roads, namely, using the mile number, with a suitable letter or prefix to distinguish each particular structure on each individual mile which is intended to be covered. I think, therefore, that in any discussion that may now take place, it would be desirable for the members to express themselves in regard to their opinion as to the preference for one or the other of these systems of numbering, namely, the consecutive system or the mileage system. The other question that the committee report on is, as to whether all openings should be numbered, or whether only a specific kind of openings, such as bridges and larger openings, should be numbered, while closed culverts would not be considered. This is also a matter for discussion and opinion. After having outlined what I think the direction of the discussion should be, I will give you my individual views. In regard to numbering structures, I am a strong advocate of the mileage system, numbering each structure with the number of the mile it is on, with a letter or prefix to distinguish each structure itself. Sometimes a system can easily be arranged so as to distinguish between the closed openings or an open opening. Bridges can be distinguished by a suita-

ble letter or designation to be added. The reasons I have for preferring the mileage system of notation are, that any one on the railroad, without being the specialist in charge of the bridges, can know at a glance that if something has to be done at Bridge 55 A or B, it is located on the fifty-fifth mile, whether he is a train-hand, a depot agent, road master, or superintendent. The objection I have to the consecutive system is, that it is only the man in charge, or the men who have particularly to do with work on the bridges or openings, who know and understand the numbers without having to hunt up a reference list. They probably carry a list with them, or know them, but no one else does. A further advantage that I see in the numbering by mileage is, that if a structure is removed by filling in the opening, it causes less disturbance in the system than if the consecutive system was made use of. In other words, I believe that if for a certain number of years, say ten or twenty, a road has been using a consecutive system of notation, and one half or one third of their structures have been abandoned or filled in, some day or other one of the officers of the road will call for a revision, so as to have the numbers run consecutively again, and then the road will be confronted with a complication in its accounts, and in speaking of a structure it will always have to be referred to as number so and so, "new" or "old" system. We find that feature in New York city on our piers, where the city has had the piers renumbered within recent years. On the other hand, in the mileage system, if a structure is filled in, it simply drops that particular letter on that mile, and it is less confusing than if there were a whole lot of numbers in a consecutive system to be dropped. I will mention in addition that the committee's report covers the question of the style, make, and cost of the sign-boards or bridge number boards, so that feature also would be correct to discuss.

Mr. O. H. Andrews.—Our system of numbering is the old-fashioned way, placing number of mile on the tie in the middle of the bridge, with date of the bridge. I have been considerably interested in this subject, and I am hardly satisfied with the way we are numbering. I am holding a system of numbers

now, waiting to see if we cannot find something better. I would like to hear from some of the members.

President.—Do you place the number on the tie?

Mr. Andrews.—Yes, midway on the bridge.

President.—Is the tie beveled on both sides?

Mr. Andrews.—It is twelve inches outside of the guard-rail and fixed right in.

Mr. Bates.—Our bridges are numbered consecutively on each division, with an initial letter for each division. Bridges are given even numbers and culverts odd numbers. Thus: number A—262 is a bridge, and number A—119 is a culvert. We have no openings in our track, except for waterways or under crossings. We do not use open cattle guards, and every open span exceeding six feet in length is known on our books as a bridge. Every opening which is covered by ballast is known as a culvert, except certain small culverts near the rails, which are designated as drain boxes, and are maintained by the road department. We make no attempt to number these drain boxes. When we fill a bridge, its number is dropped from our books. When we fill a bridge, leaving a culvert under the embankment, the culvert takes the bridge number. I think there is no question but that the system of numbering bridges and culverts by miles and decimals of miles is the best, and I do not see any necessity for making a distinction between bridges and culverts in giving them numbers. We have considered on our road the question of changing our numbers to the decimal system, and concluded that the advantages gained would not pay us for the cost of the change. Such a change would involve the numbers on more than 16,000 bridges and culverts and the advantage gained would be slight. The number boards for our bridges are of pine, 2 inches by 12 inches, with the top diamond pointed, and the division letter and bridge number stenciled in black, on a white background on both sides of the board. The number board is spiked on the end of a cap for pile and trestle-bridges, and for other bridges is put in the most convenient place, where it can be readily seen from a passing train. Our culvert boards have black letters and figures on a white back-

ground, and are made of pine and nailed opposite the culvert on a fence post or telegraph-pole, and in some instances, on a stake driven in the ground for the purpose.

Mr. A. McNab.—I am following up the system of numbering by mileage. We adopted the system five years ago, and the longer we use it the better we like it. We number by miles and decimals, painting the number on a 4x14 inch oak post, placed near the end of bridge. Every 500 feet we also have station numbers. Should a washout occur on the track, or at any culvert, or trouble of any kind, the section men report it between such and such station numbers, so that we know just the exact location of the trouble. Our culverts are not numbered. We have a great many bridges on our main line across Indiana and Michigan. We have a little book showing every bridge on the road, so that if anything occurs we know what station we want to go to in a minute's time. I must say that I am very much in favor of the mileage system in numbering bridges.

Mr. J. H. Travis.—In regard to our method of numbering bridges, I would say that we have adopted a mile number which has been in existence on some roads twelve or fourteen years. We are now renumbering all bridges on our line. We number our bridges and culverts consecutively, no matter what the character of the culvert may be, concrete, pipe, stone, or wood. We also have a division letter, the same as is used for stations and baggage numbers, designating the division, beginning with the letter A. The bridge on that division is marked A, the mile number and fraction of a mile. The shape of the numbering tie is a half of a regular standard 6x8 tie, cut in a triangular shape at the end, about two and one-half feet. We number consecutively from New Orleans to Chicago, 912 miles. The posts are beveled and the face is large enough to get on three and one-half inch letters, but I believe that is hardly large enough. Five-inch figuring would be better. The culverts are numbered with 6x6 cypress, set in the ground. Each division having this letter is properly designated so that in case a report comes to Chicago from a division away off 2,000 miles, you get the number of the division and the number of

the bridge at once. The location of the bridge is designated by the letter. It is used officially and also on all papers pertaining to the passenger and baggage departments; every person is familiar with it and I do not think any difficulty is experienced. I think it would be a disadvantage to have the work of numbering bridges separate and distinct from the road department. On most of the roads, the B. and B. department is under the control of the chief engineer, and we are only subheads of that department. The road department and the bridge department are identical. As a general thing, the bridge foreman takes care of culverts, and it is just as necessary to have the numbers consecutive on culverts as well as bridges, as the reports sometimes come from the section foreman. It is just as easy to report by mile on culverts as on bridges. I believe that the mile number is the most economical and the most satisfactory. In this connection we find it very advantageous to cultivate a good relationship and feeling with all the train crews—engineers, firemen, conductors, brakemen, etc., as a report from them sometimes saves us a good deal of trouble, as well as gives us valuable information. If they report something wrong at a certain bridge or culvert, and the correct number is not given, it does not take long to find out what the record number is.

Mr. C. P. Austin.—Our bridges are numbered consecutively on each division, which, in one sense of the word, is about the same as we have heard is the practice on other roads. I use a mile post 6x6 about six feet away from the track and ten or fifteen from the bridge, and a board 12x18 painted in white with six-inch black figures. I have 267 bridges. Everything from six feet and upwards I look after; everything below six feet the track department takes care of, and those I do not have anything to do with. The section men look out for the waterways and culverts. I have a carefully prepared list of bridges which I carry with me.

Mr. Austin then gave some minute details in reference to the *modus operandi* of numbering bridges on his road, beginning at the Boston terminal, and the clerical methods in which the records are kept. In the way he explained, no difficulty was

experienced in locating any number at a moment's notice. Everything was familiar to everybody having anything to do with the bridges on his division.

Mr. J. H. Cummin.—Our system is that of numbering consecutively. The bridges are numbered running from 1 to 300, though we do not have so many as that; our arches or culverts begin with No. 300, the overhead bridges begin with No. 500, and so on. The numbers on the bridges are made of enameled iron with a six-inch figure, the body being blue and the number white, the plate screwed on the tie. From some of the remarks made here, I should judge that the mileage system was the best on most roads, but whether it would answer in all cases, for instance, on the Long Island, I am not prepared to say. I might illustrate this by the following: Our late member, Mr. Reed, and I made a little trip last February over the Long Island. We had a four-mile trestle on the road and he was anxious to see it. We got on at Long Island City, and took a seat in the rear end of the train, and started out. We went over the trestle and stopped at different stations. Finally, I told him it was about time we got out. He got out, looked around, and then said, "Why, Cummin, we are at Long Island City, where we started from." I explained to him that we had been sitting in the rear car all the time and had gone around a loop. We have got two of these on the road, and I do not know how the mileage system would work on these loops.

Mr. W. S. Danes.—We number all our bridges consecutively on the eastern division of the Wabash, using pine boards twenty-two inches long and beveled. One of these is placed outside of the guard-rail near the middle of the bridge. The body is black and the letters are painted white. Culverts we do not number. We are filling a good many bridges, using pipes. I think that culverts should be numbered or designated by some post with the number on it, so that in case of washouts it could be located.

Mr. Eggleston.—We are numbering all our bridges by the mileage system—miles, half miles, and quarters. We have a full description of each bridge, giving length, kind, date of construction, etc., and this is kept in the office in the form of a

blue-print, and each division foreman, division engineer, superintendent, and other general officers have a copy. If any trouble arises at any of the bridges, they can look at their sheet, and see what kind of a bridge it is, and where it is located. There is no trouble in locating a bridge. We use a steel plate number, as mentioned in the report of yesterday. I think the mileage system good and very satisfactory on the whole.

Mf. A. J. Kelley.—Our road has not any system of numbering, as we have no bridges. We use street numbers, that is, street names; but if I were on a road where there were bridges, I should prefer the mileage system of numbering them. I think it is decidedly the best.

Mr. Aaron S. Markley.—About five years ago, we changed the entire system of numbering bridges. Formerly they were numbered consecutively. We adopted the mileage system, using tenths of a mile. If a bridge was 16.1 miles from the end, it would be numbered 161, and so on. All the bridges are recorded in the office of the chief engineer, and bound in book form, the numbers being given and the general description. On branch lines we prefix letters ahead of the number, same as used by transportation department in numbering stations. We have not yet decided as to the style of number we wish to put on except on through bridges, on which we paint the number on batter post. All waterways are numbered. The bridge department is under the chief engineer, and we are obliged to keep track of and look after them, and are held responsible for them.

Mr. N. M. Markley.—We number consecutively everything from east to west, and the different divisions separately, using a cast-iron plate. On trestles they are placed on a cap.

Mr. Berg.—I would like to ask Mr. N. M. Markley a question. He says they number bridges consecutively. Mr. Markley, I presume, quoted the experience of his road. I would like to bring out more definitely Mr. Markley's individual opinion on the question, as to whether he is in favor of the mileage or the consecutive system, if he had a free hand; in other words, if he were taking hold of a new road.

Mr. Markley.—I believe I am in favor of the mileage system. I forgot to state that all small openings, I mean pipe openings, are not sealed up. The iron pipe is placed in a box and set in the ground.

Mr. Noon.—Mr. President, we use consecutive numbers on our road for bridges. No box culverts are numbered, but all openings. We use two-inch pine, nine inches square, painted black letters on white boards, placed on the side of the bridge facing the engineer. I do not know but what I prefer this instead of the mileage system. We have had a great many reports from farmers, section men, and trainmen, and we have no difficulty in locating the place. Of course a new man might experience a little difficulty, but section hands are not changed very often.

Mr. Olmstead.—We use on our system for numbering a board ten inches wide and sixteen inches long. This is set up about eight feet from the track on a post, and back about twelve feet from the bridge, except on through bridges, where the number is placed on the end of the bridge. The numbers are put on the posts, one on either side of the track, and we number everything over six feet consecutively; everything under six feet is taken care of by the road department. I believe that the mileage system of numbering is far better than what we have.

Mr. Stannard.—Our bridges are numbered consecutively, omitting numbers on stone and iron-pipe culverts. I am partial to the consecutive system of numbering, as structures are more easily located. We use a bridge book which gives a description of each bridge or trestle.

Mr. Thompson.—We number all openings, no matter how small, but only put signs at openings over twenty-four inches in width. Our sign is of cast-iron, about ten inches wide, with a seven-inch figure, and long enough for figures needed, either one, two, or three. When we put in a new opening, we use the number of the last structure, with a letter following, as 50 A, 50 B, 50 C, etc. We sometimes get into confusion at that. Mr. Thompson cited a case in point where confusion had ensued. I think I would favor a system of numbering from

mile-post, giving the first opening beyond a mile-post the number of the post, say 40, and the next one 40 A, etc. Think this would be most convenient in locating a structure in case of trouble, as all employés are familiar with the location of mile-posts. Mr. Stannard says everybody knows where a bridge is,—brakemen, section men, train dispatchers, etc., but even then it is sometimes difficult for them to locate it. We have a blue-print in the dispatcher's office, showing location, but usually in case of trouble at a bridge the blue-print has got into the wrong drawer and cannot be found, so they have to inquire for the information.

Mr. Large.—Our system is practically the same as that of Mr. Thompson, so far as mileage numbers are concerned. I do not know that that would work very well where I am, from the fact that one of the lines is made up of two roads, and the mile-posts begin at both ends, and it would be a little difficult to number consistently in that case. On a line running right straight along, it seems to me it would be a very good way to number by the mileage system.

President.—We number all openings, regardless of size, first with a mile number and then with a letter, indicating the number of the bridge on that particular mile. Number 10 C would be the third bridge on mile ten from Duluth. In the case of branch roads, the general freight agent has selected one of the closing letters of the alphabet as a prefix. The letter "V" indicates Vega branch, which is a branch to one of the iron mines. On that road we have some small bridges. These bridges would be numbered V, then with the mile number, and then with a letter indicating the number of the bridge on that mile. The Western Mesaba branch has a letter "X" prefixed to it. In this way, we have a very clear and comprehensive method of numbering bridges, and any employé knows as soon as he hears of a bridge being burned or injured, the exact location. For instance, a work train being ordered out suddenly to go to bridge 14 A, the conductor knows exactly where to go, and there is no delay whatever. It is a very simple way of numbering the bridges on a road that has a limited number of openings.

Mr. Garvey.—I want to say that I have talked with our chief

engineer in regard to the matter of numbering bridges. We talked about the new method. We have a book that describes everything,—culverts, cattle-guards, crossings and overhead bridges. We talked the matter over of getting up a new book, and he is in favor of the mileage system of numbering, and if the engineers on other roads, together with the superintendents of bridges and buildings, are of the same opinion as this, I do not believe we shall have any trouble in adopting that plan.

Mr. J. P. Snow forwarded the following written discussion:

The Boston & Maine railroad system is composed of a group of what were formerly independent companies. It is made up of ten divisions which, generally speaking, follow the lines of the original organizations. The maintenance is directly in charge of the various division superintendents, who report in regard to such matters to the assistant general manager. It is the intention of the management to make the division superintendents responsible for everything, from one end of his division to the other. New construction is in the hands of the chief engineer. The supervisors of bridges and buildings are appointed by, and report to the division superintendent. In the maintenance of these structures, the different divisions are as independent of one another as they were before the various leases and agreements brought them under one management, except that a few large tools, like car pile-drivers, derrick-cars, pumps, steam shovels, etc., are occasionally transferred as the work demands, and at rare intervals a crew of special workmen, with their boarding car, is sent from one division to another to do an unusual piece of work.

This condition of affairs raised the question whether the bridges should be numbered consecutively over the whole system, beginning with unity somewhere and bringing up somewhere else with a figure between 2,000 and 3,000, or be numbered by beginning with unity on each division. The former method seemed to have two objections: First, after reaching four figures, the numbers are awkward to put on a post, and are not so easily read from a passing train. Second, it was thought that it would be unpleasant to the men on the divisions to have their numbers succeed those on some other division. The lines mostly radiate from Boston like the spokes of a wheel, so that there is but slight geographical reason for locating the starting point on any particular division. We consequently made lists some years ago, starting each division with unity and numbering consecutively through its main line and branches. Other roads were acquired by lease, and the same system was applied to them, and all went smoothly until the management found it convenient to step over the lines of the original organizations and enlarge some divisions by detaching from others. This mixed us up badly, so that now on one division we have three sets of numbers, making it necessary to name the branch as well as the number in corresponding about a particular bridge. I think the system of affixing letters is confusing and clumsy, and have reached the conclusion that consecutive numbering for the whole system is the best method, starting each division on an even hundred perhaps, to isolate them somewhat.

When a bridge is abolished by filling, or otherwise, its number is dropped out and no trouble arises, but when bridges are inserted where none existed before, we give them fractional numbers or attach

letters to the adjacent number. The abolition of grade crossings, which is a very active industry in New England at present, necessitates a large number of these insertions. Our number schedules, in consequence, are getting badly demoralized. The only remedy that I can see, is to renumber occasionally.

As to putting the numbers on the structures, we have three methods in use. First, a board, or cast plate, attached to the end of through bridges, or to the guard timber of deck-bridges. Second, a board about 12x16 inches, attached to a post, set near the bridge. Third, a plank post, six inches wide, with the figures one above the other. I prefer the latter. Its only objection is that the figures are in vertical, or Chinese order. Strangers may not know what they mean, but the road men have no difficulty. The post admits of figures on both sides, takes but little lumber and is durable. The post and board are objectionable, as the figures can be put only on one side, and they are being continually used for shot-gun targets by boys, so that their life is very short. On lines where they are used, we continually find many numbers partially or wholly gone. Where a board or iron plate is attached to the timbers of deck bridges, it is impossible to see it from a train unless it is placed in such a position that the snow-plow is pretty sure to demolish it. I would recommend putting boards on the end posts of through bridges at each end, and on the stringers of overhead bridges, well to one side of the track, to get them away from the engine smoke, and would paint these white, with black figures. The plank posts I would paint a light brown or buff, with black figures to prevent confusion with the more important whistle and other track signs, the figures in all cases to be five inches high.

As to the proper minimum limit on which to put numbers, opinions may well differ. Most commissions fix ten feet clear span as the minimum to be reported, but a bridge of eight or nine feet clear is quite a structure; it must be maintained by the bridge crew, and I think should be numbered. We have generally adopted six feet clear as the dividing line, but I think if we were intending to change from this that I would advise, as the result of my experience, extending downward to four feet at least. I would number all arches, but would not include stone box culverts, pipes, etc. I think that all overhead bridges, whether maintained by the railroad or not, should be numbered with the rest.

For the use of the various general and division officers, we make lists of each division, of which the following is an abstract:

Number.	Name.	Location.	Kind.	Clear opening.	Date.	Remarks.
209	South canal.......	S., No. Lawrence.	Pl. Gir. deck....	60-0	1887	
210	Merrimack river.	So., "	Iron pin deck..	524-3	1893	6 spans.
211	No. canal.........	So., "	Pl. Gir. deck....	95-3	1886	2 "
212	Lowell street.....	.1m. N., N. "	Framed trestle.	71-4	1892	Overhead.

The former custom on all of our lines was to designate the bridges by names and as far as practical convenience in maintenance on the ground is concerned, it is just as good, in my opinion, as numbering, and in fact I know most of the bridges on the system far better by name than by number, but when it comes to books and records, numbers are almost indispensable. We keep the original names, as far as possible, on all lists and records.

I think it preferable to locate from depots, rather than from mile-posts, as the lists tell us then how to best reach the structure, and we have a better idea where it is, than if referred to mile-posts, unless we attach to our bridge record an index of mile-posts referred to the stations.

Our regular office records are kept in note-books, convenient to carry in the field. They contain full measurements and descriptions sufficient for a full knowledge of a structure and sufficient for computing its strain-sheet; notes as to the physical condition of superstructure and substructure, the computed strains in the principal parts, its distance from nearest station, reference to plans on file, date of building, etc. This record also contains, in consecutive order, all small openings, all crossings, highway, private, farm, etc., all box culverts, sizes and condition, and all matters on which reports have to be made by the engineer department to state or government commissions. This record is made in pencil, for convenience in recording changes. They are not bulky. A common pocket field-book will cover about seventy-five miles.

I believe in addition to this that the central office should also keep books, giving a page or more to each bridge, on which is regularly recorded the reports of the periodical inspections of the structures. In this way we would have a continuous record of any changes that occur in the condition of the bridge, of the repairs made on it, and a check on the inspector himself. I regret to have to say that this is not in vogue on our road.

The supervisor on each division, or principal foreman, should carry with him, at all times, a small book, giving for each bridge the date of building, last renewal of ties, date of painting, if iron, clear span, etc., for his own information and for that of his superior officers when they are out with him on the line.

I believe, with the committee, that a simple system of numbering is the best, and would also extend this principle to the records. A complicated system of bookkeeping is not necessary. If attempted, it will probably be neglected after a short time, fall behindhand, and be finally dropped. It has certainly been found unnecessary on the roads where I have been employed, to keep a book account with each bridge to show the cost of repairs on it. The ability to state from the ledger just how much expense has been put on each individual bridge from year to year may look very enticing, but it means a great deal of clerical work and, in my opinion, will not yield an adequate return.

Mr. George W. Andrews forwarded the following written discussion:

We number according to mileage. Thus, the first bridge in second mile would read 2 A, the second one 2 B, and so on; the prime advantage in this system of numbering is that though a new bridge will or may be placed, it will not affect the number of the others; it also has its advantage in giving the exact distance of bridge from either terminal. The blue-print attached is a photographic copy of a large print we have for office use, the small one for pocket use.

The signs are placed on a 4 x 4 wooden post at end of bridge, and consist of an iron plate 18 in. x 13½ in. x ¼ in. thick, plates painted white with a black border and letters. I think it essential that all waterways should be numbered, both large and small; the system of numbering nothing under ten feet, as in use by a number of roads, seems to me to be wrong, as you well know that many of the washouts are

small openings, and where they are without numbers they are often without records, which often gives trouble that might have been avoided by numbering.

II. Drawbridge Ends, Methods of Locking; and under this head include Locking of Turn-tables.

REPORT OF C. C. MALLARD.

There are three things absolutely required for the safe operation of a railroad draw or more properly swing-bridge. They are:

1. A device that will raise the ends so as to take up the sag due to changes of temperature.
2. A device for connecting the track rails at each end, which should be one in which the swing-bridge rails are long enough to extend over its ends and find a solid bearing on the fixed structure at either end of the swing-bridge.
3. Where a swing-bridge is not heavy enough to stay in line by its own weight, it should be provided with a latch that will hold it so.

Raising the ends of a swing-bridge is accomplished in a variety of ways—by rollers with wedge-shaped bearings, by swinging rollers, by wedges, and by screws, all of which act at the ends. Another method is to raise each arm of the bridge from the centre. Of the last four, we present a number of examples of bridges that are in actual use, and request that the association take up each one separately and discuss its good and bad features. Without venturing an opinion as to the best methods of lifting the ends, we would call attention to the fact, that in bridges turned by hand, where wedges are used, they do not really raise the ends, but serve only to give them a firm bearing. As they become loose with every considerable fall of the thermometer and have to be adjusted constantly, too much reliance has to be placed in the carefulness of the bridge tender to look after it.

A recent writer on this subject says, "A swing-bridge, wherein no proper provision is made for raising the ends, is a dangerous structure at all times," and we would add that a railroad swing-bridge is equally as dangerous a structure wherein no provision is made for securely connecting the rails with those on the fixed structure at each end.

Mr. Mallard's report was accompanied by a very large number of blue-prints with explanatory letters, and also responses to his circular requesting answers to the following questions:

1. What devices do you use for securing track rails at the ends of drawbridges?
2. What devices do you use for raising ends of drawbridges when they are closed?
3. What devices do you use for locking drawbridges?
4. Do you use wedges, screws, or other devices under the ends of turn-tables to relieve the jar when locomotives go on or off them?

Mr. Charles E. Webster, chief engineer, Lehigh Valley R. R., kindly wrote in reply as follows:

1. The rail rests on a wrought plate; upon the plates are riveted clamps which hold the rail in position; the plates are securely spiked to end cross timber of drawbridge; to prevent creeping, expansion joints are introduced about three hundred feet on each side of drawbridge.

2. There is only one drawbridge in use on this system; this is constructed so that ends are lifted by means of screws at the centre; when the bridge is in place, the action is the same as two independent spans, and the pinholes in toggle bars being oblong relieve them from any weight when the ends of bridge are lowered to the support on the masonry.

3. The bridge is locked with a pin more as a guide for lowering; this kind of construction needs no locking, as its weight will keep it in place.

4. We use no wedges or other device on the ends of turn-tables to relieve the shock from locomotives moving on or off; the rail on the table is about one-half inch higher than off the table, to allow for the deflection; we have no trouble with our turn-tables.

Mr. E. J. Blake, chief engineer, Chicago, Burlington & Quincy R. R., kindly sent the following response:

1. We use split rails at the ends of drawbridges, rails from the movable span, lapping on those on the fixed span, one set of rails being lifted above the others when bridge is to be opened.

I enclose blue-print showing arrangement used at our Beardstown draw, which will illustrate this. No special device other than that shown is needed to hold the rails in position. At points where drawbridges are interlocked, the rails are locked down by bolts to prevent clear signal being given while the rails are elevated.

2. We have only five draw spans on the C., B. & Q. proper. At four of these the ends are raised by cams under the end posts of the truss or girder. These cams are operated by the same engine that swings the draw at points where draw is swung by power. At two of the five bridges, we use hand power, and at one of these we have no lifting arrangement at all, but the end of the span (which is a one hundred and seventeen foot through girder) rests on rollers, the axis of the rollers being parallel with the track. There is very slight clearance between the rollers and the bed plates of the spans, and the action is similar to that of a turn-table.

3. At interlocked drawbridges, we use a standard drawbridge lock, furnished by the Union Switch & Signal company or the National Switch & Signal company. At some other points, we have an ordinary bolt which is operated from the centre of the draw span. These bolts are principally of use to hold the bridge in place until the ends are raised, and the rails are lowered; with the span raised on cams and the rails lapping, no additional lock is needed.

4. We do not use wedges, screws or other devices under the ends of turn-ables. We have discussed this somewhat in cases where we have continuous track across the table and extended for some distance on either side and trains of cars are switched over the table, but have as yet taken no steps towards accomplishing anything in this direction.

Mr. Onward Bates sent the following reply:

1. We use a wrought-iron bed plate fastened to a heavy cross tie, or wall plate, of oak, and hold the end of track rail by bolts and lugs.

2. We raise the ends of drawbridges, either with screws, or by running them on rollers, or by lifting the ends of the bridge with a toggle-jointed arrangement at the centre, and lowering again when the bridge is closed.

3. We lock drawbridges, either with latches, or with bolts operated by springs, or by raising the ends and lowering them over the rollers on the abutments, which rollers also act as expansion rollers.

4. We do not use wedges, screws, or other devices under the ends of turn-tables to relieve the jar. We usually weight one end of the table so that it has a bearing when the locomotive goes on, and in going off at the other end it comes to a bearing without shock, because it tilts over as soon as the engine has passed the balancing point.

Mr. A. Shane sent the following reply:

I have but one drawbridge on my division, and that is a short one, being but 140 feet long, and although I have had considerable experience in the past with such bridges, yet none of them are of modern pattern, for heavy, long spans.

I favor the screw. I have never known a wedge or eccentric to work perfectly satisfactory.

On the span on our road, the locking device is a wrought bolt, 1¼x4, operated by a common wagon spring, and works automatically when closing. It is fastened under the ties. A mortise casting is imbedded in the masonry at the centre, and the face of pier lined with a wrought plate. The bolt strikes this plate, and slides as the draw closes, until the bridge is in position, when the bolt shoots, and the span is held securely in position. To open the span, a chain is run from this bolt to the centre of bridge, where it is drawn back with a crank, and held until the draw moves off its bearing, which is a ten-inch roller under each corner, which the bridge rolls on to as it swings into position.

The rails are seated in a grooved chair, and are held more firmly with a knuckled strut between the rails, which can be lifted out by catching it at the centre, and raising up, or connecting same with a rod, and working on the principle of an eccentric.

When I say that, with the exception of renewing one spring, there has not been a dollar expended on this span, for lifting or locking it, in twelve years, you will conclude that that is recommendation enough for use on a small bridge.

Our arrangements cannot be classed as modern ones, and they have nothing but their simplicity, effectiveness, and durability to recommend them.

Mr. J. H. Cummin sent very carefully prepared tracings (Figs. 6, 7, 8, 9), showing the locking and lifting devices of the Main street drawbridge, No. 46, of the Long Island Railroad, built by the Pencoyd Bridge & Construction company in 1890, with the following information: The bridge has been used continuously since erection, as a single track bridge, and has given good satisfaction. It is operated by one man, and the time required to open and close bridge, including setting of signals, is five minutes and forty seconds, divided as follows: Setting signals, fifteen seconds; lifting rail and draw-

ing wedges, one minute; opening bridge, one minute, forty-five seconds; closing bridge, one minute, thirty-five seconds; setting wedges and lowering rail, thirty-five seconds; setting signals, thirty seconds. This time is for using slow gear for turning, as two men are required to operate on fast gear.

Mr. George W. Andrews writes, that in answer to the fourth question, with reference to ends of turn-tables, the B. & O. R. R. depend entirely on the pony wheels at ends of table, and that no wedge arrangement is in use on any of them.

Mr. G. J. Bishop writes in answer to the fourth question: "We do not use wedges or screws under the ends of our turn-tables to relieve the jar. Our fastening for turn-tables is generally a latch thrown with a lever. The latch is about one and a half inches thick by four inches wide, and runs in a socket, which is set in the coping of the turn-table."

Mr. James Brady writes that no wedges, screws, or cushions, of any kind are used on their turn-tables, to relieve the jar of engines going on or off of turn-tables.

Mr. T. H. Perry, chief engineer, Lake Erie & Western Railroad, kindly furnishes the information that they do not use any wedges, screws, or other devices, on the ends of turn-tables to relieve the jar, when the locomotives go on or off the tables. The end wheels of the turn-table resist the jar.

DISCUSSION.

President.—A report has been presented on this subject, and we would like discussion on same. In this discussion, I would like all members who have experience with drawbridges and turn-tables, to take part in the discussion.

Mr. Stannard.—There is a report from Mr. Mallard, and I have a drawing furnished by Mr. Danes, of the Wabash road, showing device for locking turn-table in use on his road, by which a turn-table can be locked before coming to a dead standstill. As far as drawbridges are concerned, I have not got a drawbridge, and therefore have got nothing to offer under that head.

Mr. Danes.—The drawing referred to represents a new turntable that was recently put in. It has a new kind of a fasten-

ing, that works with a shaft, with the leverage working at the sides. It works and fastens between the two rails, so that a man operating it is not in risk of getting hurt. It is a great deal better than the old fastener. This is the first turn-table of this kind that we have put in on the road, and it is entirely satisfactory.

Mr. Cummin.—I would like some information as to whether any roads have on their tables a device to loosen or lessen the jar of the engine, when it strikes the table in going on or off.

Mr. Danes.—I do not know of any such device, but it seems to me that could be overcome.

Mr. Cummin.—It seems to me the only turn-table is one that can be brought to a dead stop before the man locks it.

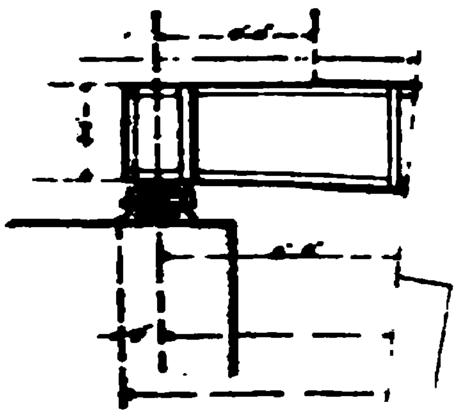
Mr. Danes.—The table has got to be brought to a stop, and the man has got to be pretty careful.

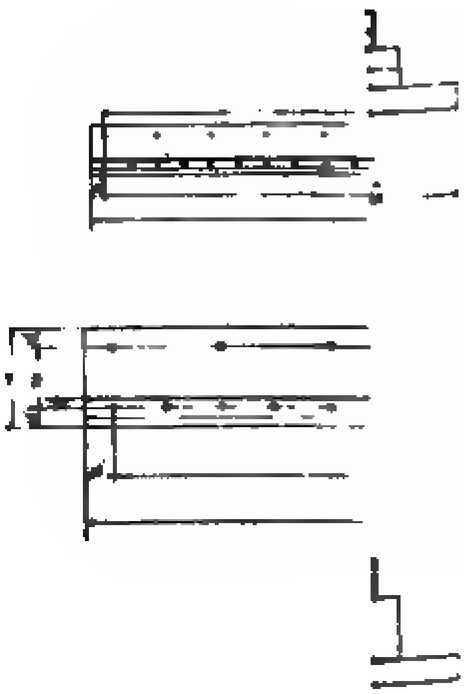
Mr. Cummin.—Where you have a fastening with a table that can be used to bring the table to a stop, you are bound to have the table out of order all the time. I have had considerable experience in that way.

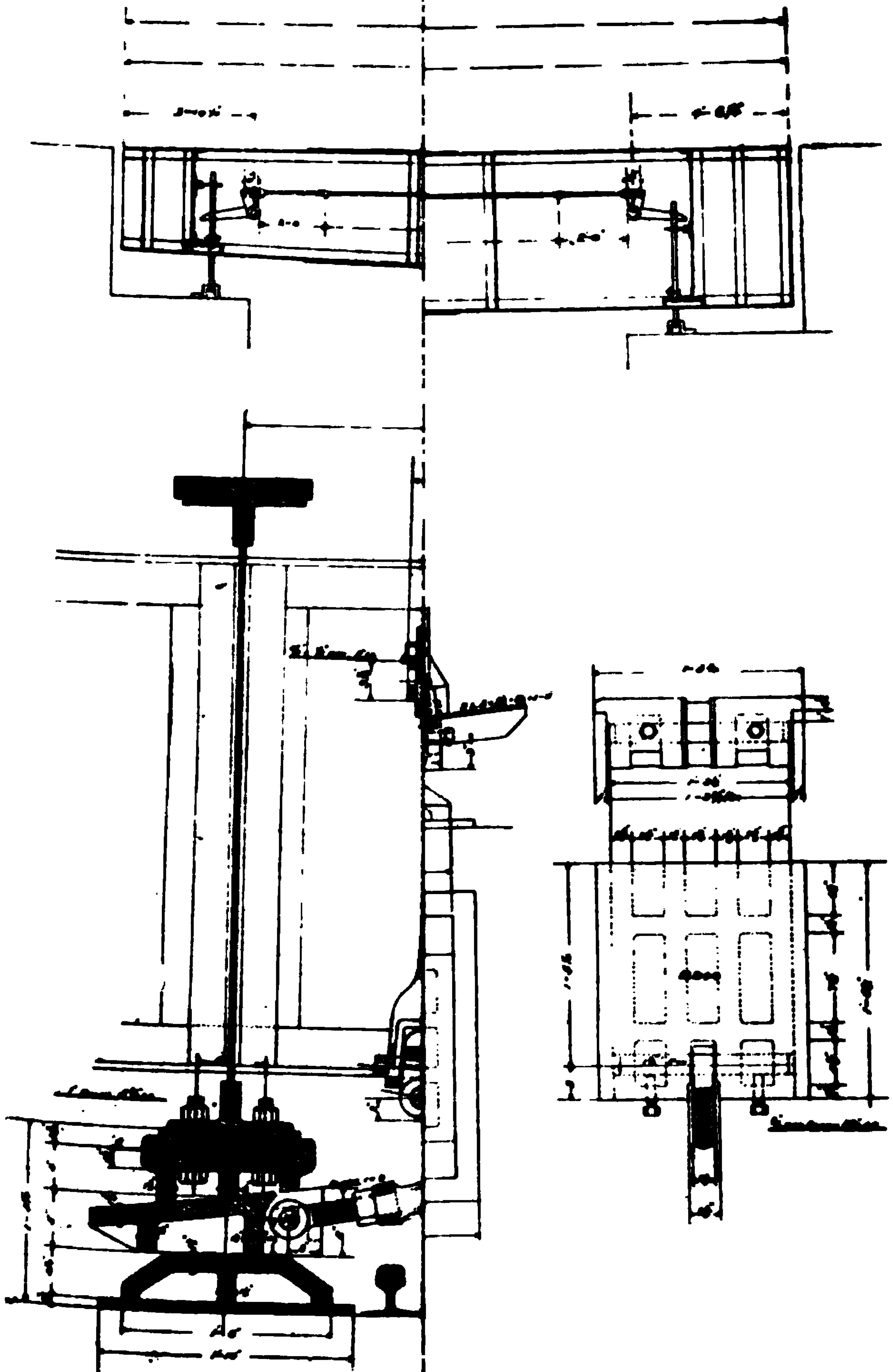
Mr. A. S. Markley.—About a year ago, when at New Orleans, I saw a good fastening operated with a lever on the side of the engine, which seemed to work well. We have but one draw-bridge on our line. We have one on the Wabash river that has never been locked, and one on the Calumet river. They are operated from the engine on top.

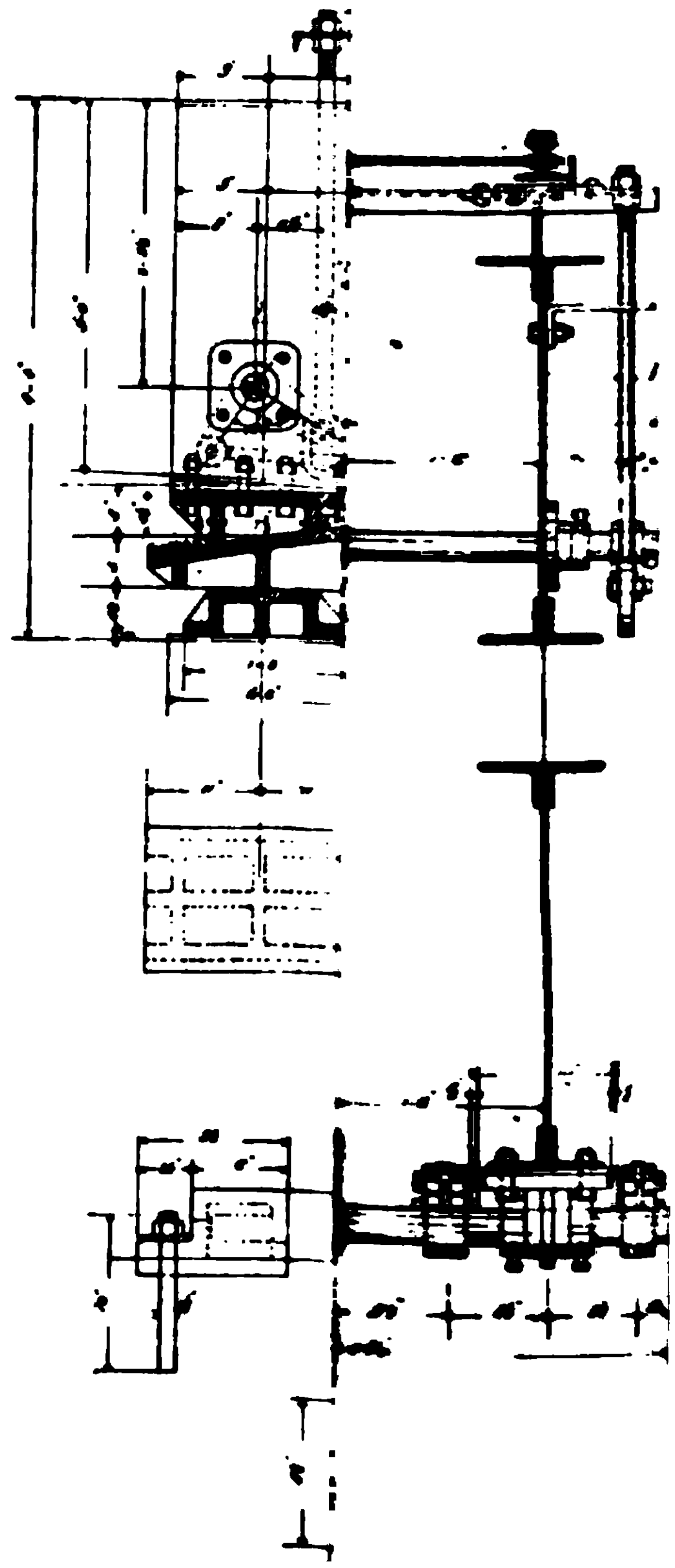
Mr. Berg.—In answer to Mr. Cummin, I will say that I do not know of any special device, but have always heard that the introduction of ties or timber for the foundations of the circular rail of a turn-table, is generally indorsed, because they are more elastic. In other words, the placing of a circular rail of a turn-table on a stone coping direct, has been quoted as bad practice, for the reason that it increases the shock to the turn-table. I know of no special device to reduce the jar of the engine in going on or off the turn-table.

Mr. Bates.—I am reminded at this moment of a circular letter that was sent to me some years ago by a man who is now one of our most distinguished engineers, asking for copies of the plans in the office where I was employed. His letter stated









that he wanted not only examples of our good bridges, but especially wished for the drawings of our bad ones as well, because, as he ingeniously stated, he could perhaps learn more from the contemplation of our failures than our successes. I am in a better position to advise you what to avoid than what to adopt. At a later date, when I have carried out some ideas on the subject, which are not yet developed, I may have a drawbridge latch which I can recommend. At the present time, with twenty-five drawbridges, there is not one which I consider entirely satisfactory with regard to the end-locking apparatus. Probably the best of the lot is a spring bolt which shoots in place when the bridge is closed. The objection to this is that the fastening receives a violent shock when the bolt is shot in place before the bridge is at rest, and in practice this shock usually occurs. We have one bridge where the ends of the bridge are lifted up and dropped down on rollers, which act as expansion rollers as well as a lock to hold the bridge in place sideways. I have not furnished any plans of these appliances, because it seems to me there is no place in our publication for plans unless they can be recommended for adoption.

Mr. Riney.—We use the old method of latch or the tie plate and key on turn-tables, and the old-fashioned methods on drawbridges.

President.—I hope the members that have a satisfactory device for operating drawbridge ends and turn-tables, will rise and give us the benefit of their experience.

Mr. McIntyre.—We have drawbridges with mitred joints. The joints are two feet long and the neck of the rail is filled out to the outside, but the track there does not last over two years. On all our turn-tables we have a latch. To overcome the jar on them, we have on some of them stone, but the most satisfactory way is timber under circular rail.

Mr. J. H. Markley.—As far as the locking apparatus is concerned, it works very satisfactorily. When you want to open the draw there are four sets of rollers, one on each corner. They raise on a cast-iron pedestal, and when you come to close them they roll against the shoulder on the outside of the pedestal. I have had a great deal of trouble with rollers at the end of

bridges. I use now nothing but the stub ends, and they have to be renewed about every three years. I have been thinking some of using the mitre joint, but have been afraid of expansion and contraction. If the mitre joint can be used satisfactorily, I will adopt it.

Mr. Large.—I have never had any experience with drawbridges. We used to have a couple of small ones across the canal, but they lasted only a few years and we abandoned them. As far as turn-tables are concerned, we use a bolted frame in through the ties with a bolt and slot in it. We make it so that the levers run out and push the table. Our men are admonished to be careful. This bolt makes a very secure fastening.

President.—I would like to ask if any one has turn-tables operated by steam or electric power, and the locking device connected with the same motive power?

Mr. N. M. Markley.—We use a latch to hold it in place after the engines are released from turning it around. The rim would catch and throw it around when anything would hold it.

Mr. Thompson.—At Fort Wayne, we have a one hundred foot turn-table worked by steam engine at the car shops. Lock is between the rails, the old style. The engineer works the whole thing. We have had very little trouble for five or six years. They hardly ever disturb the curbing or get off the track.

Mr. Stannard.—The laws of Missouri require us to keep our turn-tables locked when not in use. We use a latch, keeping our tables locked all the time. I think possibly that is the best arrangement for locking.

Mr. Eggleston.—We have two drawbridges on our line, one at Hammond. That bridge is not open more than once or twice a year, and we have no special device attached to it. At Spencerville, we have a draw sixty-eight feet long. We have a special device there furnished by the Union Switch & Signal company, with three levers attached at the centre of the bridge. These levers are interlocked, similar to interlocking crossing levers. The first lever will drop one signal to danger; that releases lever No. 2, and that lever will drop signal on opposite end and that releases lever No. 3 that locks the bridge at the

ends. The bridge tender then raises the ends of the rails and opens draw. This is a very satisfactory arrangement, as we have connected with this a signal protection. This arrangement can be seen in the Union Switch & Signal company's catalogue.

Mr. Berg.—I wish to call attention to a serial article on "Drawbridges and Details of Drawbridges" that has just commenced in the *Engineering Record*. The first issue was October 17, 1896. This series of articles bids fair to be one of the best and most practical treatises on drawbridges that we have. It is written by Mr. Charles H. Wright of the Edgemoor Bridge works, Wilmington, Delaware. I understand the articles are advance sheets from a forthcoming book on the subject. I think the details are going to be very elaborately described and illustrated, so that members seeking information on this subject will be able to get it.

Mr. Cummin.—I have been listening for some device that would be better than what is now in use, but so far the only satisfactory one that we have, I think, is the slide-bar. We use slide-bar, and the table has to be brought to a full stop before they can slide the bar in. When they turn an engine, they have to bring the table to a full stop before they can slide, because we do not allow over one-sixteenth inch play. The table is brought to a full stop before the bar is slid in.

Mr. Garvey.—I agree with Mr. Cummin that we must have a device that the table must come to a full stop before being locked. I have tried different methods, but we are now using the old-fashioned way, a key between the rails. We have one bridge with a locking device of the Phoenix Bridge company's manufacture, and this is set down into cast-iron chairs. The engineer raises the ends of the rails up three inches before he starts to turn.

Mr. Eggleston.—We use the same device as Mr. Cummin. We are a little more liberal, we allow a quarter-inch play. Table has got to come to a full stop before being locked. I think that is the only way a table can be taken care of.

III. Protection of Trestles from Fire, Including Methods of Construction.

REPORT OF G. W. HINMAN.

To the President and Members of the Association of Railway Superintendents of Bridges and Buildings:

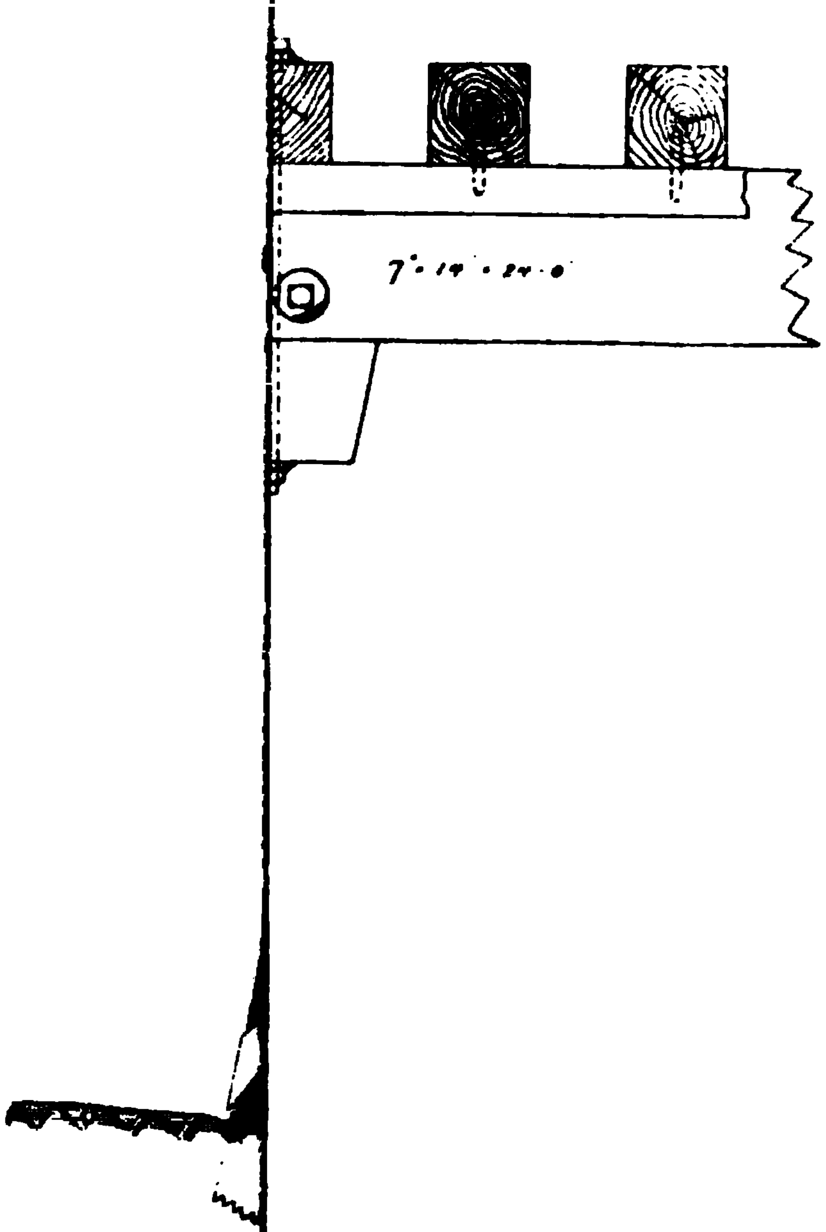
Being a member of your committee on the subject of "Protection of Trestles from Fire, Including Methods of Construction," after corresponding with Mr. R. M. Peck, the chairman of your committee, and being advised by him that it was doubtful if he would be able to make a report on account of pressure of business and asking me to make a report, I submit the following:

I herewith hand you a tracing of a trestle-bridge, which shows the iron covering of the parts of the trestle that are most liable to take fire from passing engines. You will note that I have covered the caps and rail joists with iron, these members being the ones that usually catch fire. I use No. 20, B. G., galvanized iron, twenty-five inches wide for caps, and bend the edges down on an angle of forty-five degrees. This iron for the cap is made of two pieces twenty-five inches wide and seven feet, nine inches long, spliced in the centre, lapping six inches, using flat-head, soft iron, tinned rivets, five-sixteenth of an inch in diameter, three-eighths of an inch long, placed in the centre of lap two and one-half inches apart. The rail joists are covered in the same way. You will note that on the tracing I have three stringers, 7 x 14, in each chord. This requires iron thirty-three inches wide to cover them. The iron ought to turn down at least five inches on each edge of the rail joists. It will use up one-half inch in turning the iron down. You want to order your iron eleven inches wider than the timber you wish to cover. The splicing is the same as on the caps. The iron for covering the rail joists should not be less than ten feet long, and should be riveted in sections of three sheets each, and the sections lapped six inches when laid on the rail joists, and not riveted together, to allow for expansion. The anchor bolts that go through the ties, rail joists, and bolsters and the tie dowels will keep the iron in place.

Trestle-bridges covered, as described above, cannot take fire from passing engines. Occasionally a tie may be set on fire, but it cannot communicate with the rail joists, and, consequently, no serious damage results from it. Neither is there any danger from fire caused by cinders dropping from ashpans of passing locomotives lodging on the caps. The iron is turned down over the corner of the side of the cap and rail joist on an angle of forty-five degrees, and anything that falls upon either when it slides off, is bound to fall clear of everything connected with the trestle.

Trestle-bridges, when some portion of them are on dry ground for a part of the year, should have the sod and grass cleaned away from the bents a distance of at least three feet, as cinders are liable to fall from a passing engine and set the grass or sod on fire, which would communicate to the bents and burn the trestle.

Trestles, in some parts of the South, are protected from fire by fitting a plank between the ties and closing the ends by fitting a board between the ties and nailing it fast to the bottom plank, and filling the space between the ties with gravel, and covering the tops of the ties at least half an inch. I think this a very good protection from fire if the spaces are kept full of gravel or sand, the gravel being best as it is not so liable to be lost out by the cracks between the ties and the plank.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About the only objection I can see, is in renewing the ties which wear out first, as they generally require two sets of ties to one of rail joists, and in this case the gravel would have to be renewed, but the cost is small. Respectfully submitted,

G. W. Hinman,
Sup'r B. & B., L. & N. R. R.

Evansville, Ind., Oct. 14, 1896.

DISCUSSION.

Mr. Eggleston.—We cover our stringers with No. 22 galvanized iron and protect two or three inches on the side opening. That is the only protection we have on the Erie.

Mr. Cummin.—The only protection we have is a half barrel of water certain distances apart. We have never had any trestle burned.

Mr. Thompson.—We use 8x18 oak stringers, 7x10 oak ties, and 12x13x14 oak cap. We scarcely ever have fires.

Mr. Danes.—We do not have any extra protection. We generally cover the stringers with No. 16 galvanized iron, lapping it over the girder, and at the trestles we have half barrels some distance apart, filled with water. We have no trouble with fires at bridges.

Mr. Noon.—We have no protection except water-barrels filled. If required, we use an engine tank fitted with a pipe, or have a special engine if occasion should require it.

Mr. Bates.—We depend on the track department. Bridge men only get over the road at irregular intervals, while the track men see the bridges every day. It is the duty of the track men also to clear away the grass, weeds, and rubbish that is liable to catch fire from sparks and set fire to pile and other wooden bridges. Track men also keep water-barrels filled with water on all long bridges. We usually put salt in these water-barrels to keep the water from freezing, and keep a bucket in the bottom of each barrel for use in putting out fires. On our western lines, particularly in Minnesota and Dakota, we are especially liable to have our pile bridges burned, because it is the custom to burn the straw after threshing in the fall of the year, and prairie fires are common. It is remarkable that we have never had a train accident due to the burning of a bridge, and the carefulness and vigilance of

our track men are very apparent in the few cases of damage to our wooden structures by fire.

Mr. N. M. Markley.—All has been said that I could say. On long trestles we have a barrel filled with water.

Mr. Hinman.—I have just made a report that covers all I can say.

Mr. Nutting.—The only protection that we use at this time of the year is, that we clean up thoroughly around trestles and burn up everything that is liable to take fire from sparks. At a few of our larger trestles, which are more liable to catch fire, we keep watchmen to see to the water-barrels, as an additional precaution.

Mr. Berg.—The question of the protection of trestles from fire, I think, could be subdivided into two divisions; one, the method of construction; the other, the means and appliances to fight a fire, in case a fire should take place. In regard to the methods of construction, it seems to me the more substantially or fire-proof a structure can be made, the better it would be. One method that is adopted on some roads for a timber trestle is building a solid floor and covering it with gravel; in other words, a so-called gravel-top trestle. It is a method that should be mentioned as probably a very feasible one to prevent a trestle from taking fire, and it is used very extensively. Another method, that is used for the same purpose, is to cover the ties between the guard-rail and the rails proper, and then between the rails again with sheet-iron or galvanized sheet-iron. This method I do not think favorably of. Unless it is well maintained, it will, after a number of years, show holes and it will buckle up in places and cost considerable for renewals, and, unless it is kept in good repair, it does not protect properly. It has also the further disadvantage that in case of a fire it is very difficult to get down to the structure below to get at the fire. It also interferes with the proper inspection of the trestle by track-walkers from above. I think it is an objectionable method of construction. The method of protection of the vital parts of the trestle, that is, the stringers and caps, as outlined by Mr. Hinman in his report, seems to me to be preferable. It protects the important parts of the

trestle, and the fire, as he remarks in his report, might spread to the ties, but they could be readily replaced. An individual tie could be burned badly and yet the rails would carry the trains over. In regard to a further method of protection from fire, such as has been mentioned by a number of members, namely, cleaning away weeds and other matter around the base of the trestle, that is a very good precautionary protection. There is another point that should be mentioned; that is, the necessity and desirability of having gang-planks on the outside of a trestle. I believe there are lots of trestles that are not built this way, and in case of fire it is very difficult to get down to the trestle in a hurry. This gang-plank is also of advantage in regard to inspections, and it also is desirable to allow men getting caught on a trestle to get out of the way of trains, instead of clinging on to the edge of the caps, as they often have to do. Another feature is the building of ladders, or nailing of small strips on the outside posts of the trestle, at intervals, so that in case of fire it can be got at from below more quickly. In regard to means for fighting a fire, I think railroad companies should give more attention to equipping their locomotives with fire hose or ordinary washing-out hose, fitted up so as to be used as a fire hose. We had a fire recently on our road, in one of our yards, and out of a large number of switch engines there were only two at the time in the yard that were equipped in that way and that could be used to put out a fire. It was a freight car that started to burn. That brought home to me the desirability of having all locomotives equipped so that in the event of its being necessary, a locomotive could run out on a trestle where there was a fire and extinguish it. The great point in stopping a fire after it has started is, as all the members know, to get at it quickly and stop it soon after the start. For this purpose I think water-barrels placed along the trestle at frequent intervals are especially desirable, but there should always be buckets in connection with the barrels, preferably on the inside and kept wet, unless made of metal. From the limited experience I have had or heard of on the roads I have been connected with, in regard to chemical fire-extinguishers, I have come to the conclusion that whenever a

fire breaks out the chemical fire-extinguisher is generally found to be out of order. It does not act. I have yet to learn of a fire on a railroad structure where they worked successfully. I will not say it is always the fault of the extinguisher, as generally such apparatus is allowed to deteriorate, not having the proper inspection.

Mr. Bishop.—We take no special precautions against fire. We keep weeds and grass cleared away from each side of the trestle for about ten feet.

IV. Local Stations for Small Towns and Villages, Giving Plans of Buildings and Platforms.

REPORT OF COMMITTEE.

To the Officers and Members of the Association of Railway Superintendents of Bridges and Buildings.

Your committee appointed on the subject of "Local Stations at Small Towns and Villages," giving plans of buildings and platforms respectfully present the following report:—

On March 17th, 1896, a circular issued by the committee was sent to each member of the Association of which the following is a copy:

"*To the Members of the Association of Railway Superintendents of Bridges and Buildings:*

At the last meeting of the Association, held in New Orleans, the undersigned were appointed a committee to report on the subject of 'Local Stations for Small Towns and Villages,' giving plans of buildings and platforms. We believe that this subject is of vital interest to every member of our Association, as it is from the station and its surroundings that the stranger gets his first impressions of a town or village, and first impressions, as you know, are usually lasting. In looking over the reports of our proceedings, we find that they are becoming more interesting and valuable every year, and if our Association is to grow, this certainly should continue. We think that you will agree with us that this depends entirely upon the committees appointed and the assistance they receive from the members; and in view of this we ask you to assist us in making our report one in which we can all take pride, and one that will be of great value to our members by helping them in one of the most important branches of our work.

This you can do by sending to the chairman, or any member of the committee, plans of such stations on your road as you think are appropriate. If you can possibly send tracings, please do so, as it will save considerable expense and they will be returned; but if not, send blue prints and tracings will be made. In accordance with a resolution passed at the last meeting, all reports have to be in the secretary's possession thirty days before the meeting; we, therefore, ask that you will kindly send plans, etc., as soon as possible, so that the committee can make a full and complete report on the subject assigned them.

J. H. Cummin—L. I. R. R.
N. M. Markley—C., C., C. & St. L. R. R.
J. H. Markley—T. P. & W. R. R.
C. G. Worden—S. Cal. Ry. Co."

A number of the members responded by sending plans, and the committee have had tracings made of them and now present them for your consideration.

Plan No. 1.

represents a frame, combination depot 21 feet x 54 feet on the Buffalo division of the Lehigh Valley R. R., with waiting room, office, and freight room and 8 feet of overhang of roof entirely around building.

Plan No. 2.

Passenger station on the Missouri Pacific R. R., 17 feet x 49 feet, with two waiting rooms; ticket office 9 feet x 10 feet.

Plan No. 3.

Passenger station on the Missouri Pacific R. R., 26 feet x 82 feet, with two waiting rooms 17 feet eight inches x 23 feet 10 inches each; office 11 x 15 feet; baggage and express rooms, toilet rooms with ventilating flues in the chimney are provided for each waiting room. The roof has 8 feet overhang.

Plan No. 4.

Combination station on Duluth & Winnipeg R. R., 24 feet x 88 feet, with two waiting rooms, office, and large freight room.

Plan No. 5.

Combination station on Chicago & Eastern Ill. R. R., 16 feet x 40 feet, with waiting room 11 feet 2 inches x 15 feet; office and freight room. This station cost $500, which includes outside W. C. and coal house. Waiting room is ceiled with hard pine and all sash hung with weights. Telegraph table, shelves, etc., of quartered oak.

Plan No. 6.

Track elevation and floor plan of passenger station on Ill. Central R. R., 20 feet x 76 feet, with two waiting rooms, baggage and freight room. A special feature of the plan is a vestibule adjoining the office for trainmen's use while getting orders.

Plan No. 7.

Combination depot on Union Pacific R. R., 20 feet x 50 feet with waiting room, office, and freight room; also sleeping room for agent 8 feet x 8 feet. Floor plan shows arrangement for outside toilet rooms and coal house.

Plan No. 8.

Passenger station on the Southern California R. R., with freight house and shed adjoining. The two buildings are connected at the roof, giving a cool passage way between, where seats are stationed. This arrangement is made for the comfort of the passengers, as in this climate a stove is needed only a few days in the year. The open shed at the end of the freight house is for the convenience of fruit packers in packing and shipping their stock. The location of the ticket office, giving both an outside and inside door, makes it convenient for agent to transact business with the public.

Plan No. 9.

Frame passenger station 16 feet x 26 feet on the Elgin, Joliet & Eastern R. R., showing elevation, section, and floor plan. Platform 16 feet wide and 200 feet long.

Plan No. 10

gives elevation and floor plan of combination depot on the same road, 28 feet x 64 feet 6 inches.

Plans No. 11 and No. 12.

Combination depots on the L. E. & St. Louis R. R., one 18 feet x 50 feet and the other 18 feet x 48 feet. Passenger platform 16 inches above the rail and 3 feet from outside of rail to edge of platform.

Plan No. 13.

Passenger station at Colorado Springs on the U. P. D. & G. R. R., showing elevations and floor plan. The waiting rooms are conveniently arranged with toilet rooms to each and 10 feet x 10 feet baggage room in rear of station.

Plan No. 14.

Standard combination station No. 2 on the Chesapeake & Ohio R.R., showing front and end elevation, section, floor plan, and general lay-out of platforms. Frame depot with brick foundation and platform built on brick piers with 6 in. x 8 in. sleepers, 4 in. x 8 in. stringers, and 2 in. plank.

Plan No. 15.

Frame passenger station on the Pennsylvania Line, West of Pittsburgh, 21 feet x 70 feet; showing front and East elevation and floor plan. The elevations show a neat and tasty design and the floor plan is well arranged for the convenience and comfort of passengers, giving two waiting rooms and large toilet rooms for both sexes, with baggage room 12 feet x 20 feet.

Plans No. 16 and No. 17.

Showing elevations and plans of two brick and stone stations on the C., C., C. & St. L. R. R., one at South Side, Ohio, the other at Home City, Ohio. These stations are designed entirely different from the general run of railroad depots and present a beautiful and attractive appearance, and with the general lay-out of the floor plans, will attract attention at once. For a village station it would be difficult to improve on them.

Plans No. 18 and No. 19

give elevations and floor plans; a frame station at Richmond, Ky., on the Louisville & Nashville R. R. Station is 75 feet long x 32 feet deep at the deepest portion. The elevations show a great deal of taste and care in design, and the floor plan is well laid out. There is one peculiarity in this plan, inasmuch as it has three waiting rooms, one each for men and women and one for colored people, which makes it quite different from those in other sections of the country. The rooms are large and airy and the entire plant convenient for station agent's duties. The building is covered with slate. The platforms are built 6 inches above the top of rail and 4 feet, 6 inches from centre of track to edge of platform.

Plan No. 20.

Plan of modified depot No. 1 as used on the Chicago, R. I. & Pacific R. R. Frame building 22 feet x 65 feet x 12 feet high; shingle roof, one waiting room, office, two living rooms, and freight room. This class of depot is used at small villages and costs as follows: Foundation, $107.60; depot, $1,195.00; painting, $128.61; platform, $130.67; total cost, $1,561.38. Platforms in front and at ends of depot 2 in. plank; the balance along track is two stringers set on edge, 8 feet out to out, ¾ in. rod and cast washers every 8 feet filled in with cinders and well rolled. Two in. wood platform costs 10c. per sq. foot.

Plan No. 21.

Shows brick and stone depot 26 feet x 88 feet on the same road. Slate roof, two waiting rooms, express and baggage rooms, and two

toilet rooms. This style of station is used in towns of 3,000 to 5,000 population and costs $7,500, using a vitrified brick platform, stone curbing costing about 5c. per sq. foot on the flat and 7¼c. on edge, curbing 4½ in. thick, 30 in. deep, 25c. per lineal foot. The ground is excavated the necessary depth, well rolled with 2,200 pound roller, then filled with 4 in. of sand. The sand is leveled off with straight edge, the brick then laid and rolled with the same weight roller. Joints well broomed with sand for one week after platform is laid. This platform gives good satisfaction.

PLAN NO. 22.

Frame combination depot at King's Creek, Ohio, on the N. Y., L. E. & W. R. R. Building 16 feet x 40 feet with slate roof and costs $1,200.

PLAN NO. 23.

Frame passenger station on the same road 21 feet x 43 feet with two waiting rooms and commodious office. The elevations present a neat appearance and the cost of the building with slate roof is $1,300.

PLAN NO. 24

gives elevations and floor plans of a fourth-class frame station on the Phila. & Reading R. R. These stations were designed by our esteemed member, Mr. John Foreman, twenty-seven years ago, and have been in constant use with very little repairs since that time. They are conveniently arranged for business, at the same time giving the agent a comfortable home of six rooms.

PLAN NO. 25

shows plan and elevations of a frame combination station at South Ottumwa on the Wabash R. R. The building is 20 feet x 58 feet, with bay on each side. The elevations present a neat appearance and an octagon tower extends above the ridge of roof. It is ceiled inside with long leaf yellow pine and finished in hard oil. The agent can get to any part of the building direct from his office. The section shown gives a good idea of the inside finish and trim. The cost of building, including platform, is $1,659.85.

PLAN NO. 26

shows elevations and ground plan of a frame combination depot on the Wabash road of larger size. The building is 22 feet x 150 feet with several breaks. The elevations are drawn with a great deal of taste and command attention, the roof being surmounted by a neat tower. The floor plan is well arranged, giving a large amount of room for the different purposes for which they are intended. The waiting rooms are provided with toilet rooms and the agent's office is up to all requirements. Separate rooms are given for baggage and express, and the building as a whole is fitted for the business of a large town. The inside finish is yellow pine finished in hard oil and the cost of building, without platforms, is $3,554.27.

PLAN NO. 27

gives elevations, section, and floor plan of a small standard, combination depot on the Wabash R. R., 16 feet x 56 feet, showing the construction of the platforms, which are made of old bridge timbers. This depot has the same inside finish as the others and costs, without platforms, $1,095.45.

Plan No. 28.

Elevations and plan of a small passenger station on the Boston & Maine R. R., at Seabrook. There is but one waiting room, but convenient toilet rooms are provided, together with a baggage room.

Plan No. 29.

Elevations and plan on the same road at Walnut Hill, Mass., of somewhat similar design as No. 28.

Plan No. 30.

Elevations and plan of similar design at Sunapee, N. H.

Plan No. 31.

Floor plan and photograph of frame station at West Manchester, Mass. The arrangement is good and it is evident that the building is in an exposed situation by the number of radiators necessary to keep it warm.

Plan No. 32.

Front elevation of brick and stone station being erected at Manchester, Mass., by the Boston & Maine R. R.

Plans No. 33 and No. 34

show front and rear elevations and floor plans of two stone stations on the Southern Pacific R. R., at San Carlos and Los Guilucos. These plans are worthy of the attention of every member of the Association, as the designs are about perfect, not only in the effect of the elevations but also the arrangements for the comfort of the public.

Plan No. 35

gives elevations, section, floor plan with section showing stationary cases and closets in agent's office of a frame passenger station on the Toledo, Peoria & Western R. R., 20 feet x 60 feet, 10 inches, with two waiting rooms and office; also showing construction of platforms.

Plans No. 36 and No. 37

show elevations, floor plans, and sections of two frame combination depots on the same road; one 18 feet x 54 feet and the other 14 feet x 38 feet, 4 inches, giving interior details and also construction of platforms.

Plan No. 38.

Elevations, floor plan, and section of brick depot at Glen Cove, Long Island. The outside finished with washed brick laid in red mortar. Rubbed bluestone sills and trimmings; tile roof with copper gutters and leaders. The under side of overhang of roof and the interior of building finished with narrow yellow pine on which is one coat of wood-filler and two coats of spar varnish. The platforms are concrete, running entirely around the building and 400 feet along the track. On each end of the passenger platform is a raised baggage platform 13 feet x 26 feet, level with the car floor. These baggage platforms are built at all stations on this road to facilitate the handling of baggage and express, which is very heavy during the summer months. The cost of this station with platforms complete was $9,736.-34.

PLAN No. 39.

Brick station at Oakdale, L. I. A two story structure with living rooms for the agent. Inside finish three coats plaster painted a light terra-cotta color. The platforms at this station are wood; 3 in. x 8 in. yellow pine stringers resting on chestnut posts set 3 feet in the ground and 6 feet centres. The stringers are laid 3 feet centres and 1¼ in. to 2 in. yellow pine used for planking. High baggage platforms are placed at each end.

The committee feel that, in the above list of stations, the members of the Association have had placed before them lists that will repay them if they are carefully studied, but at the same time we regret that the members sending in plans did not go more into the style and construction of platforms and also the cost of the buildings sent in. We have no doubt, however, that this part can be fully brought out in the discussions of this report.

Respectfully submitted,

J. H. CUMMIN,
N. M. MARKLEY,
J. H. MARKLEY,
C. G. WORDEN,
Committee.

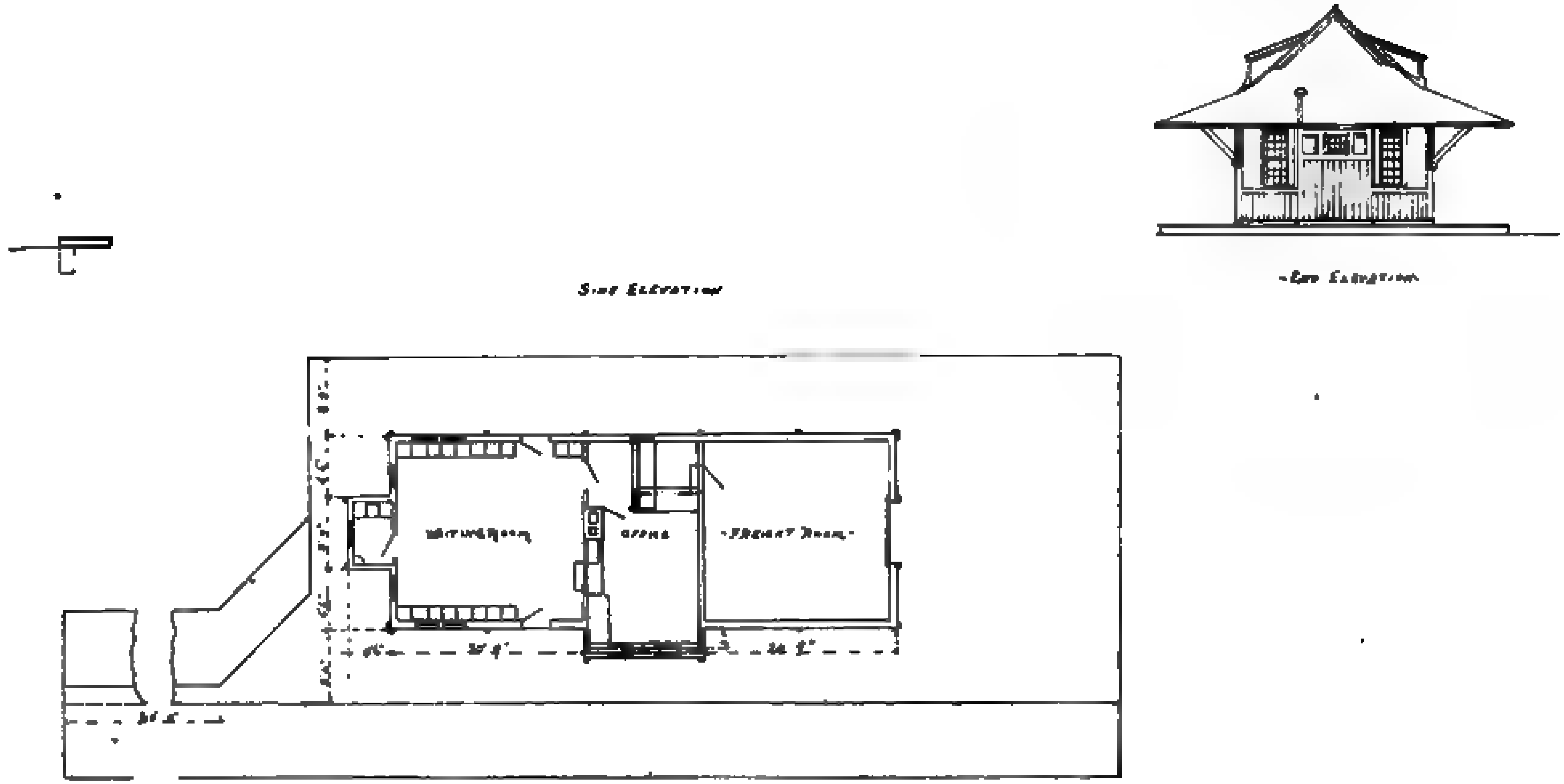


FIG. 11.—Local Combination Depot, Buffalo Division, Lehigh Valley Railroad. (Plan No. 1, Committee Report on "Local Stations.")

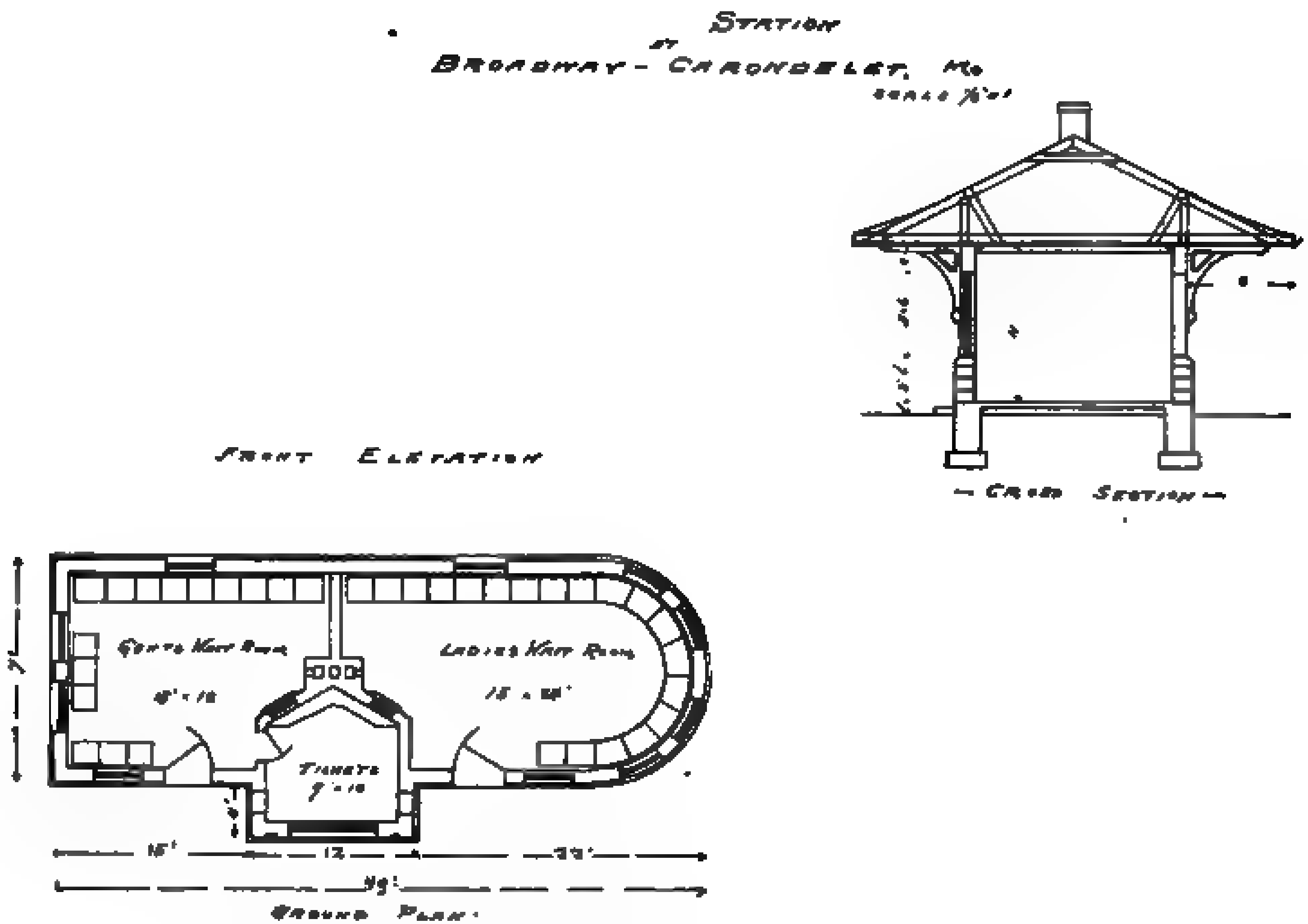


FIG. 12.—Local Passenger Depot at Carondelet, Mo., Missouri Pacific Railroad. (Plan No. 2, Committee Report on "Local Stations.")

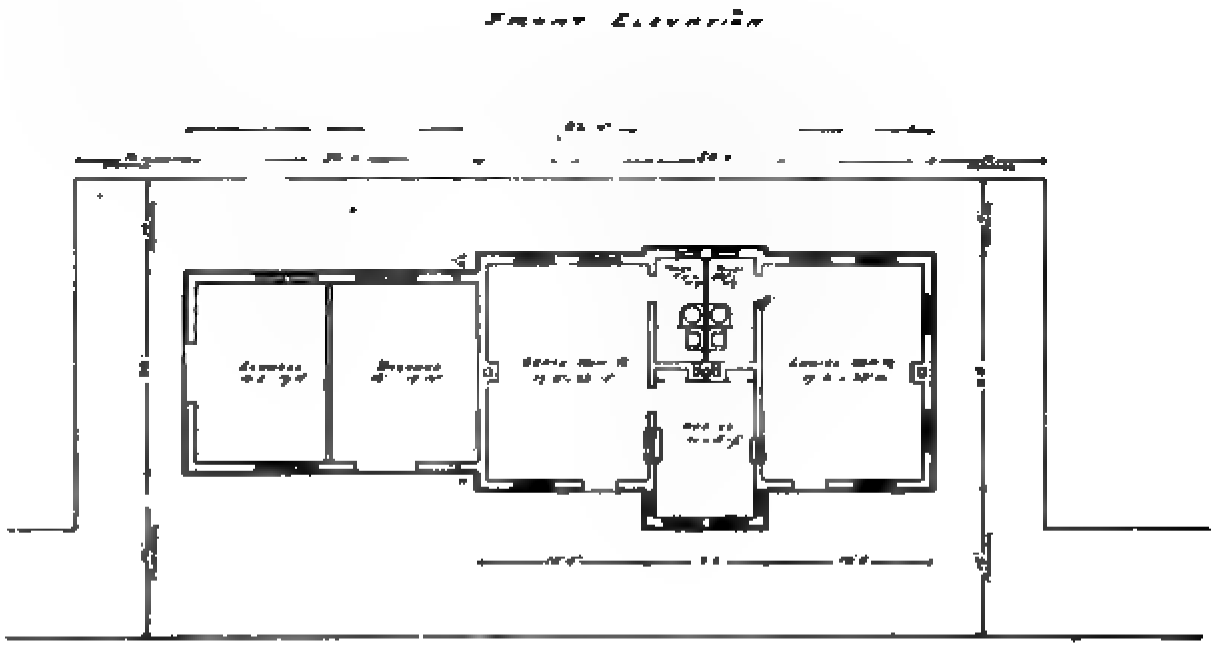


Fig. 13.—Local Passenger Depot, Missouri Pacific Railroad. (Plan No. 3, Committee Report on "Local Stations.")

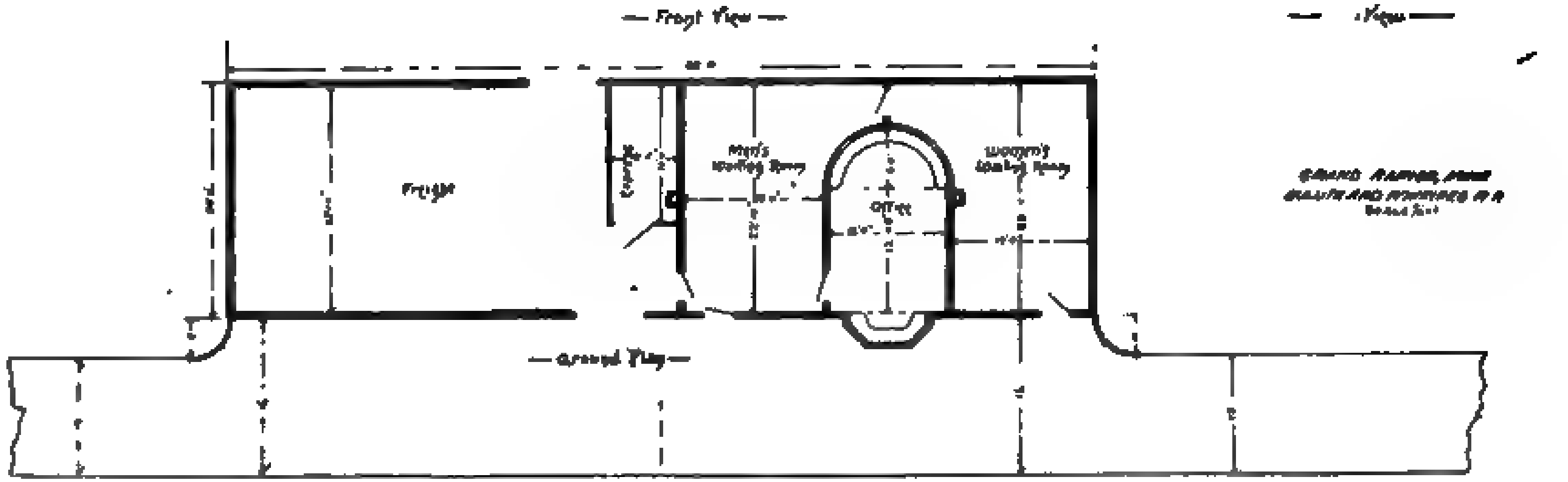


FIG. 14.—Local Combination Depot, Duluth & Winnipeg Railroad. (Plan No. 4, Committee Report on "Local Stations.")

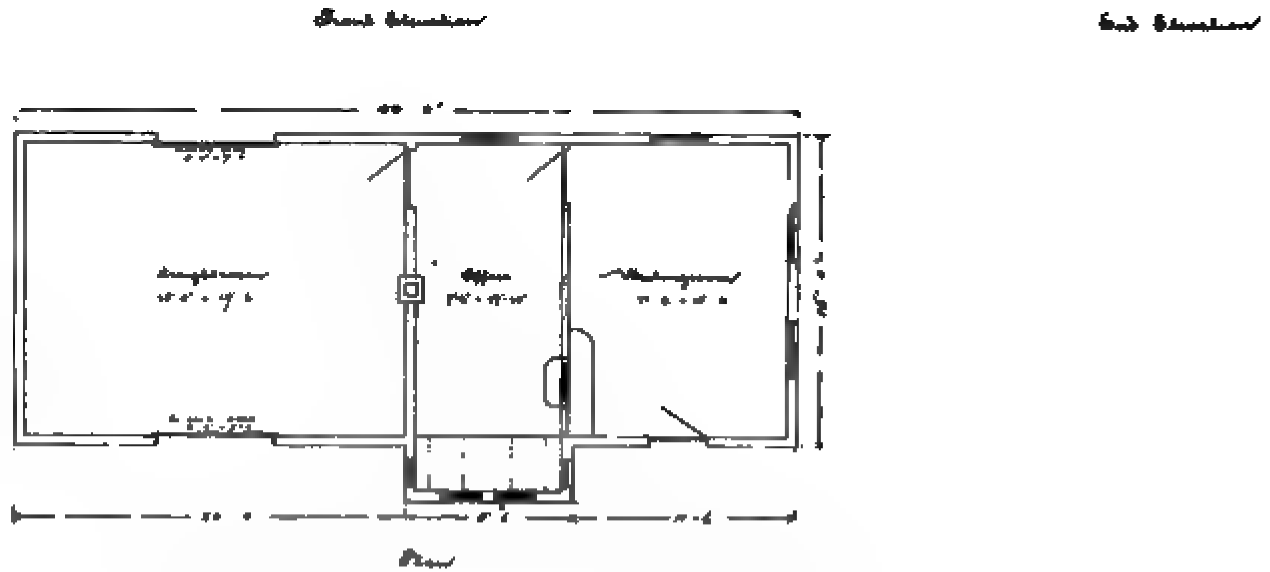


FIG. 15.—Local Combination Depot, Chicago & Eastern Illinois Railroad. (Plan No. 5, Committee Report on "Local Stations.")

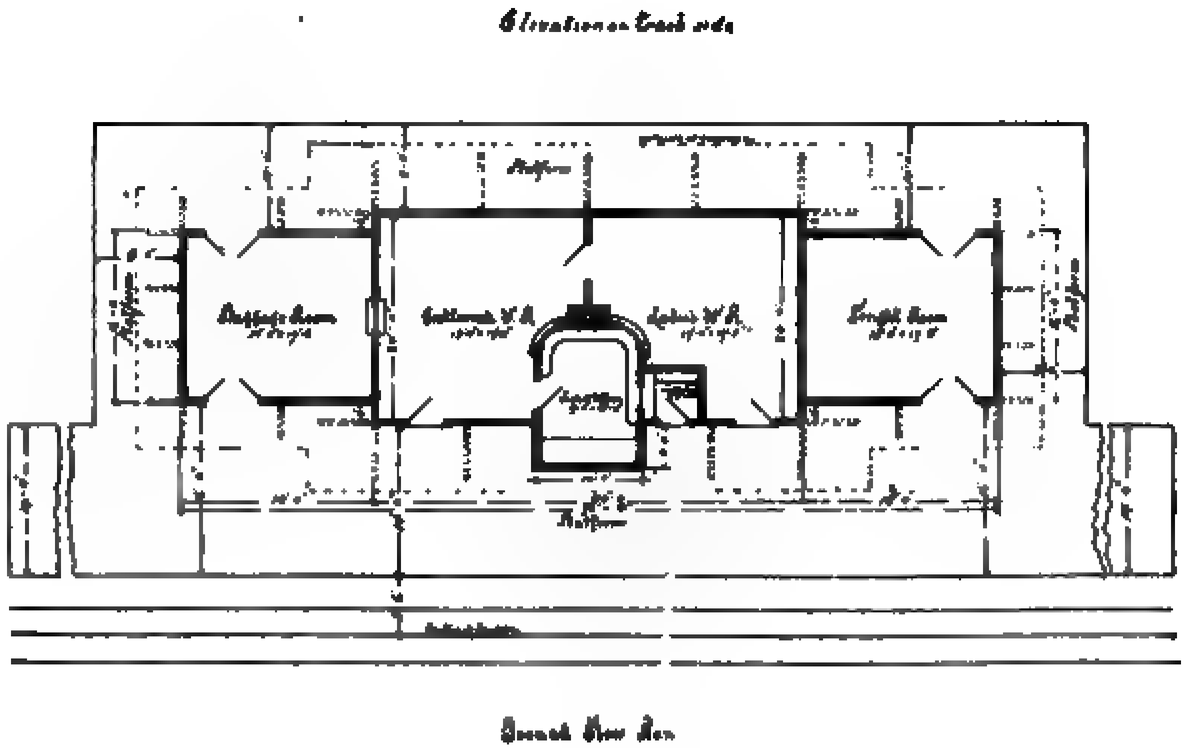


Fig. 16.—Local Passenger Depot, Illinois Central Railroad. (Plan No. 6, Committee Report on "Local Stations.")

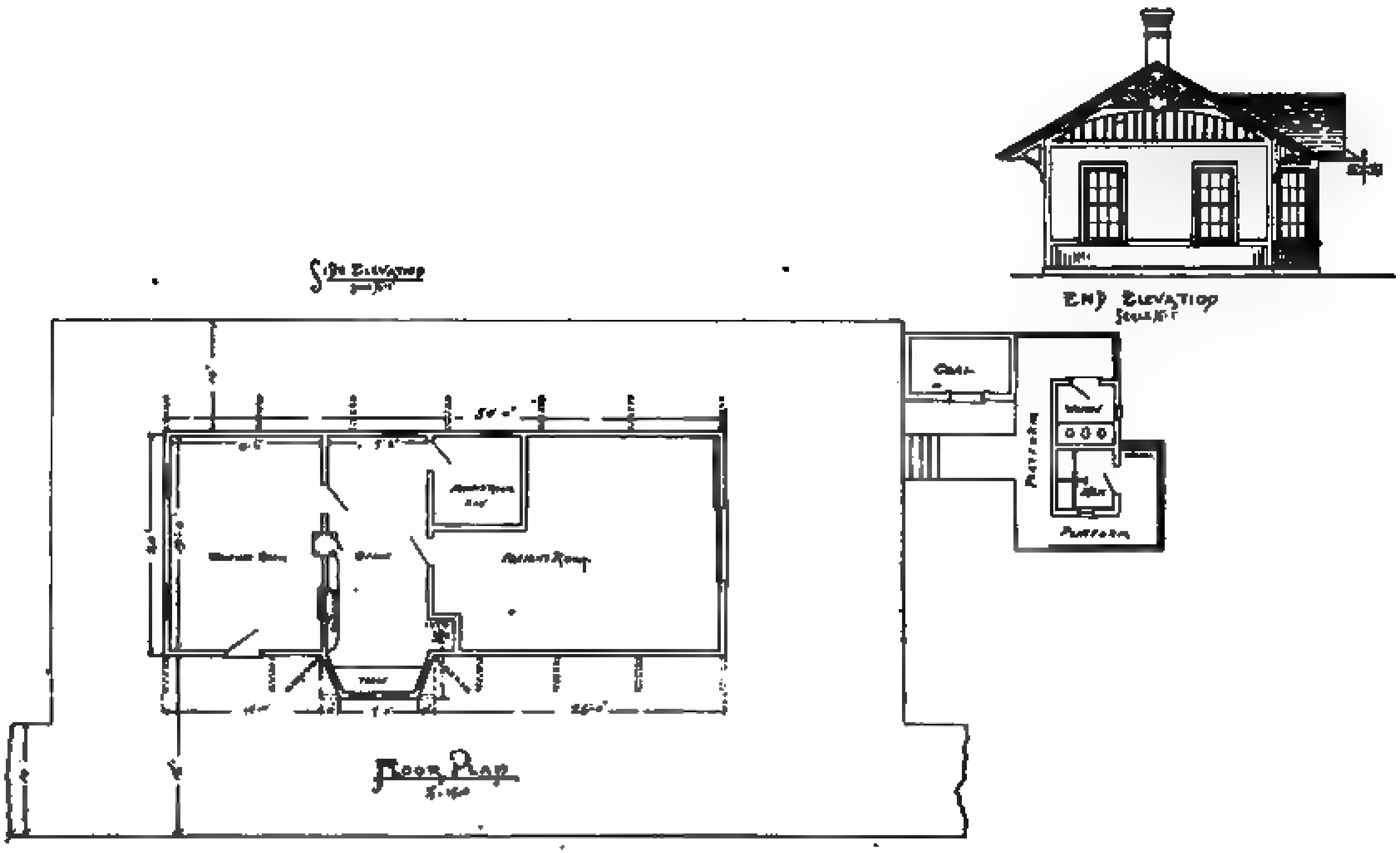


Fig. 17.—Standard Local Combination Depot, Union Pacific Railroad. (Plan No. 7, Committee Report on "Local Stations.")

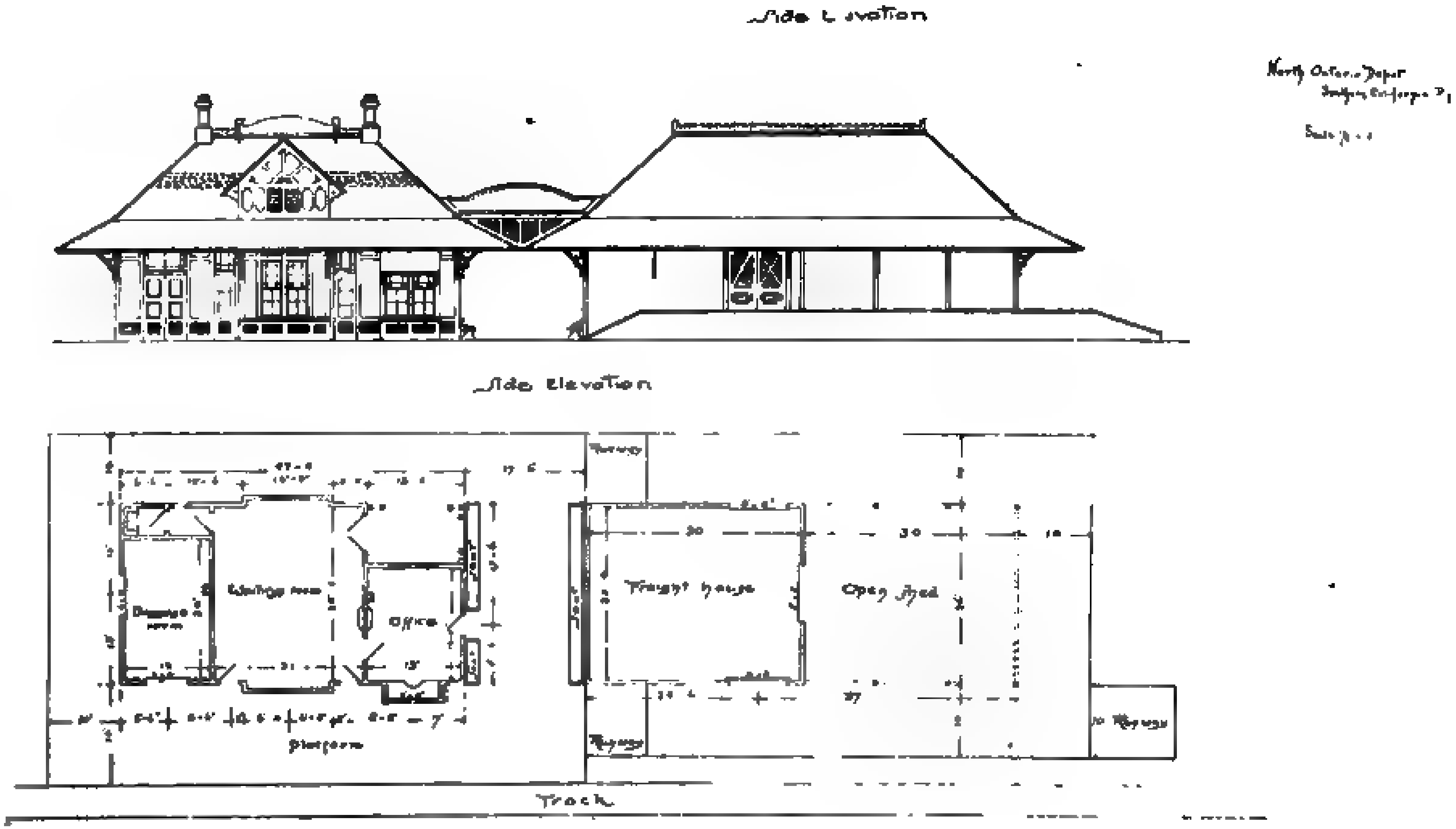


FIG. 18.—Local Combination Depot, Southern California Railroad. (Plan No. 8, Committee Report on "Local Stations.")

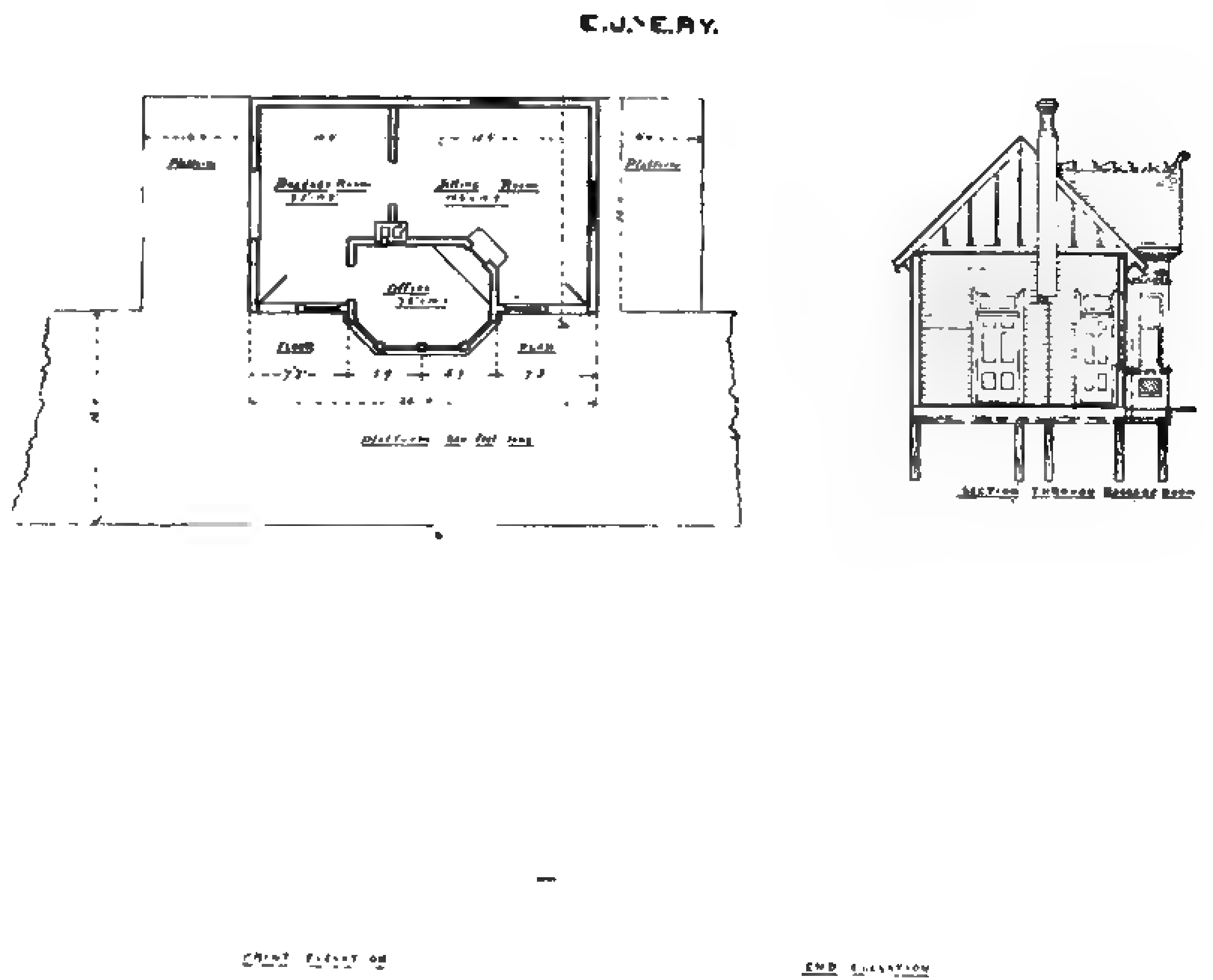


FIG. 19.—Local Passenger Depot, Elgin, Joliet & Eastern Railroad. (Plan No. 9, Committee Report on "Local Stations.")

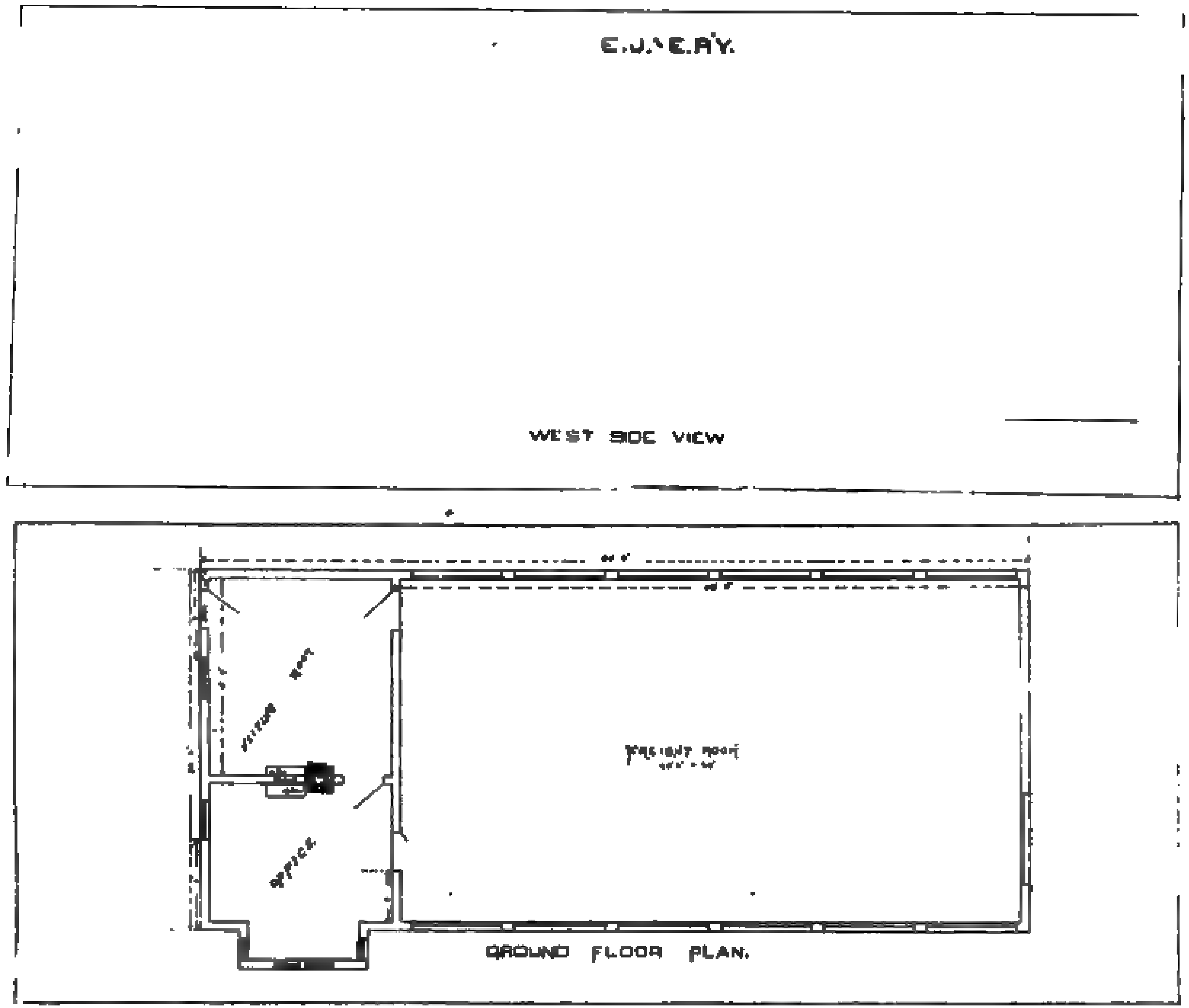


FIG. 20.—Local Combination Depot, Elgin, Joliet & Eastern Railroad. (Plan No. 10, Committee Report on "Local Stations.")

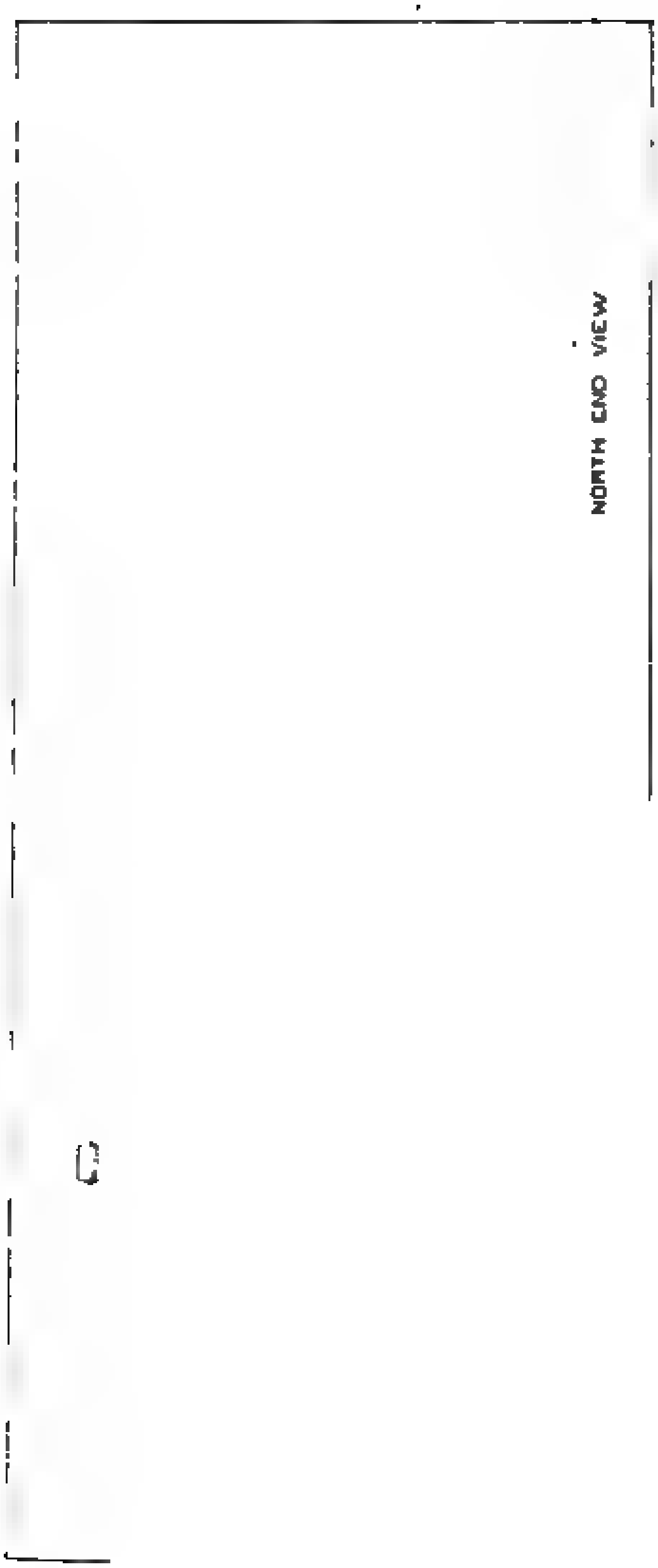


Fig. 21, Plan No. 10.—*Continued.*

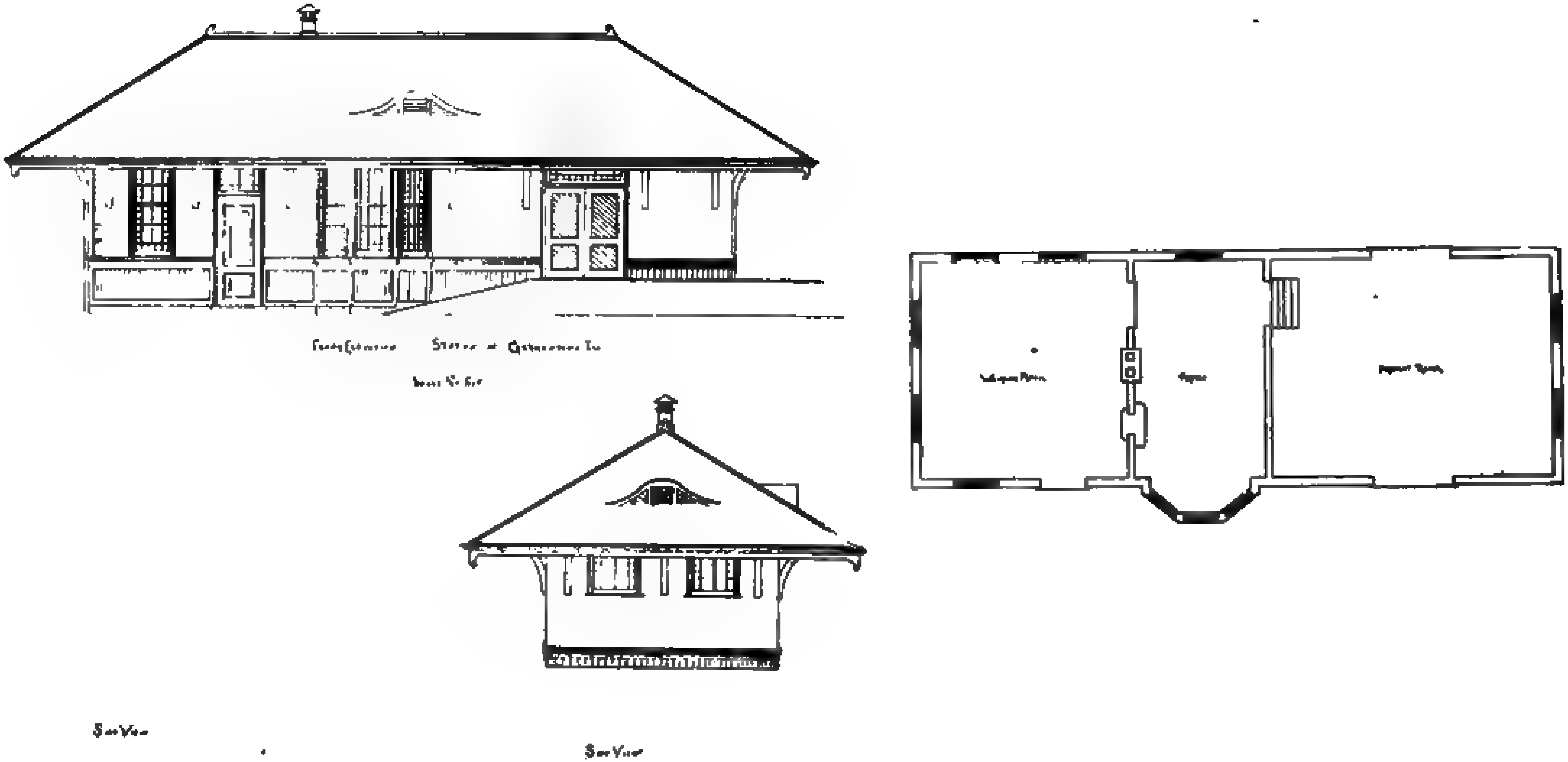


FIG. 22.—Local Combination Depot, at Germantown, Ill., Lake Erie & St. Louis Railroad. (Plan No. 11, Committee Report on "Local Stations.")

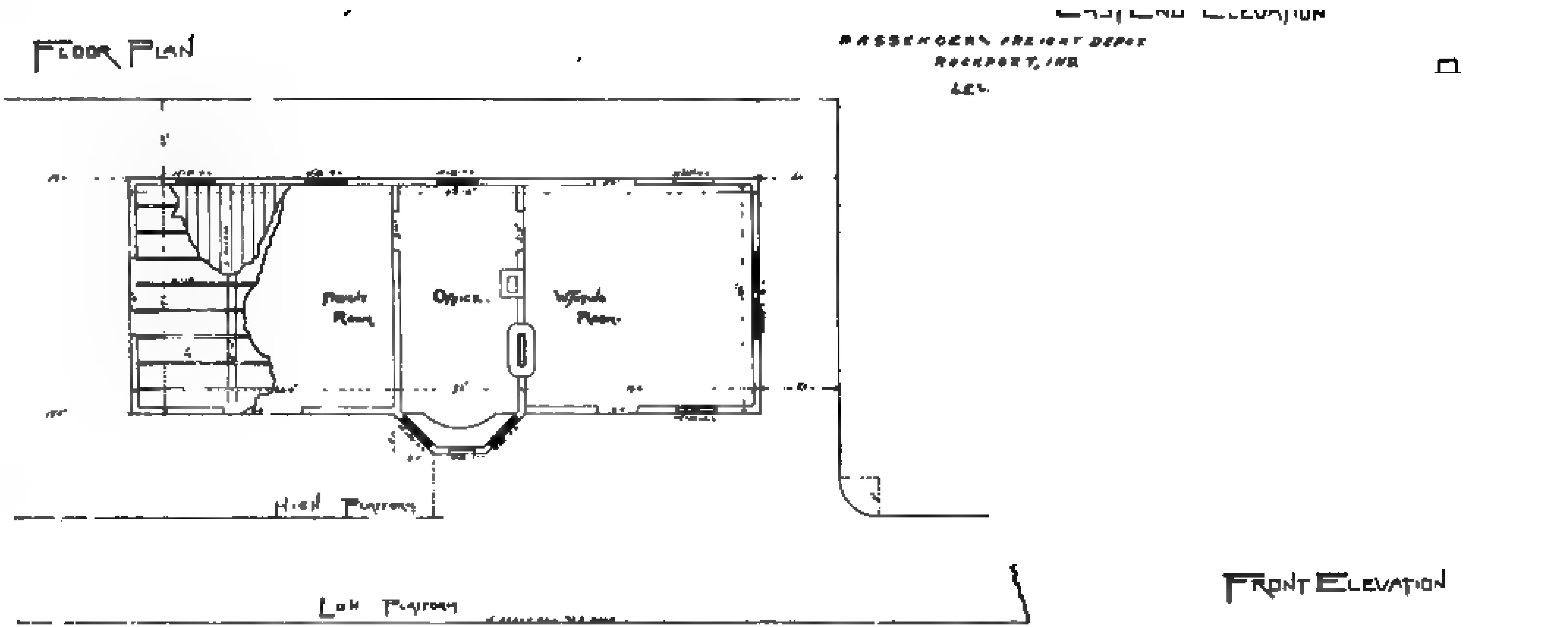


FIG. 23.—Local Combination Depot at Rockport, Ind., Lake Erie & St. Louis Railroad. (Plan No. 12, Committee Report on "Local Stations.")

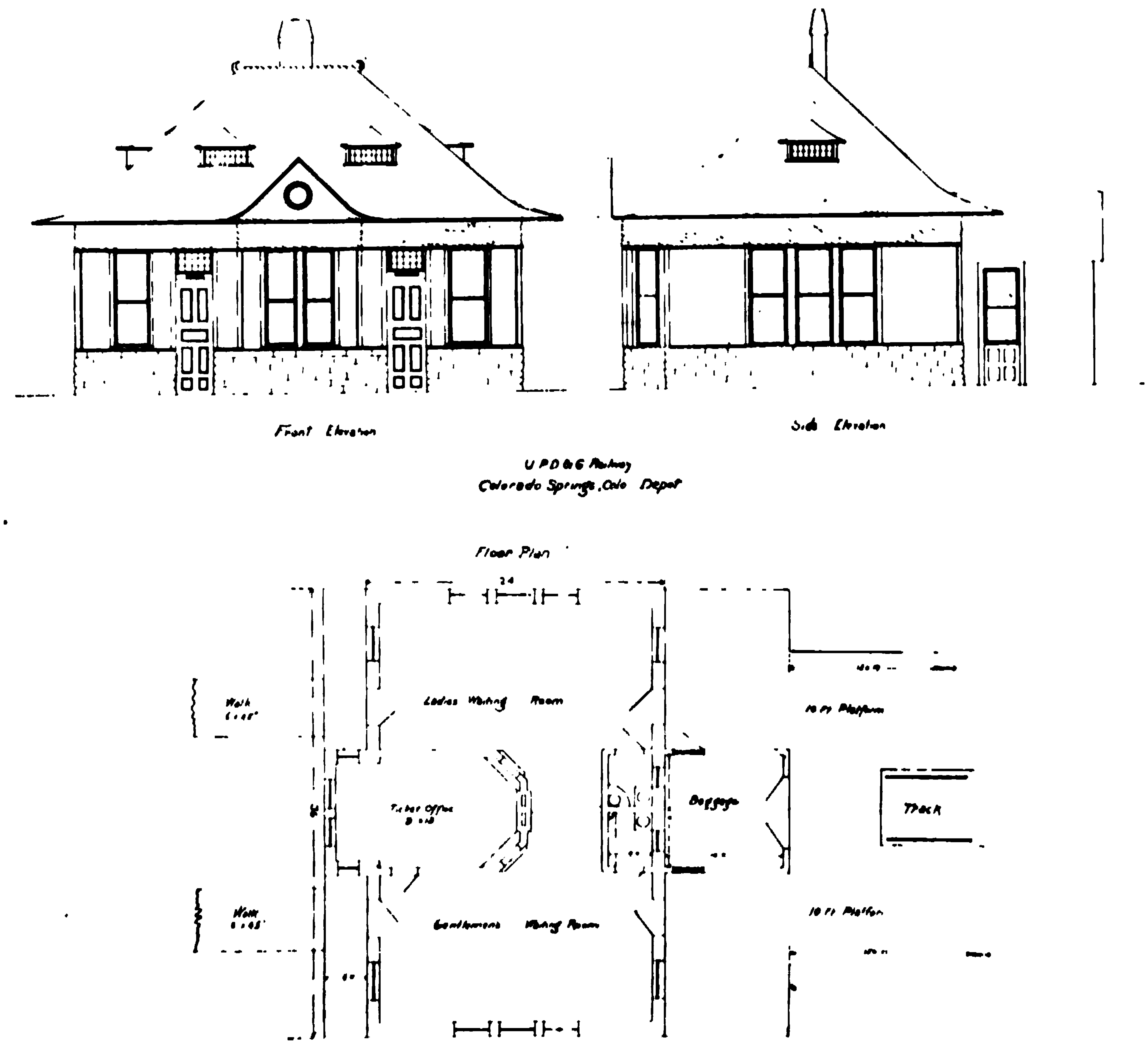


FIG. 24.—Local Passenger Depot at Colorado Springs, Col., U. P., D. & G. Railway. (Plan No. 18, Committee Report on "Local Stations.")

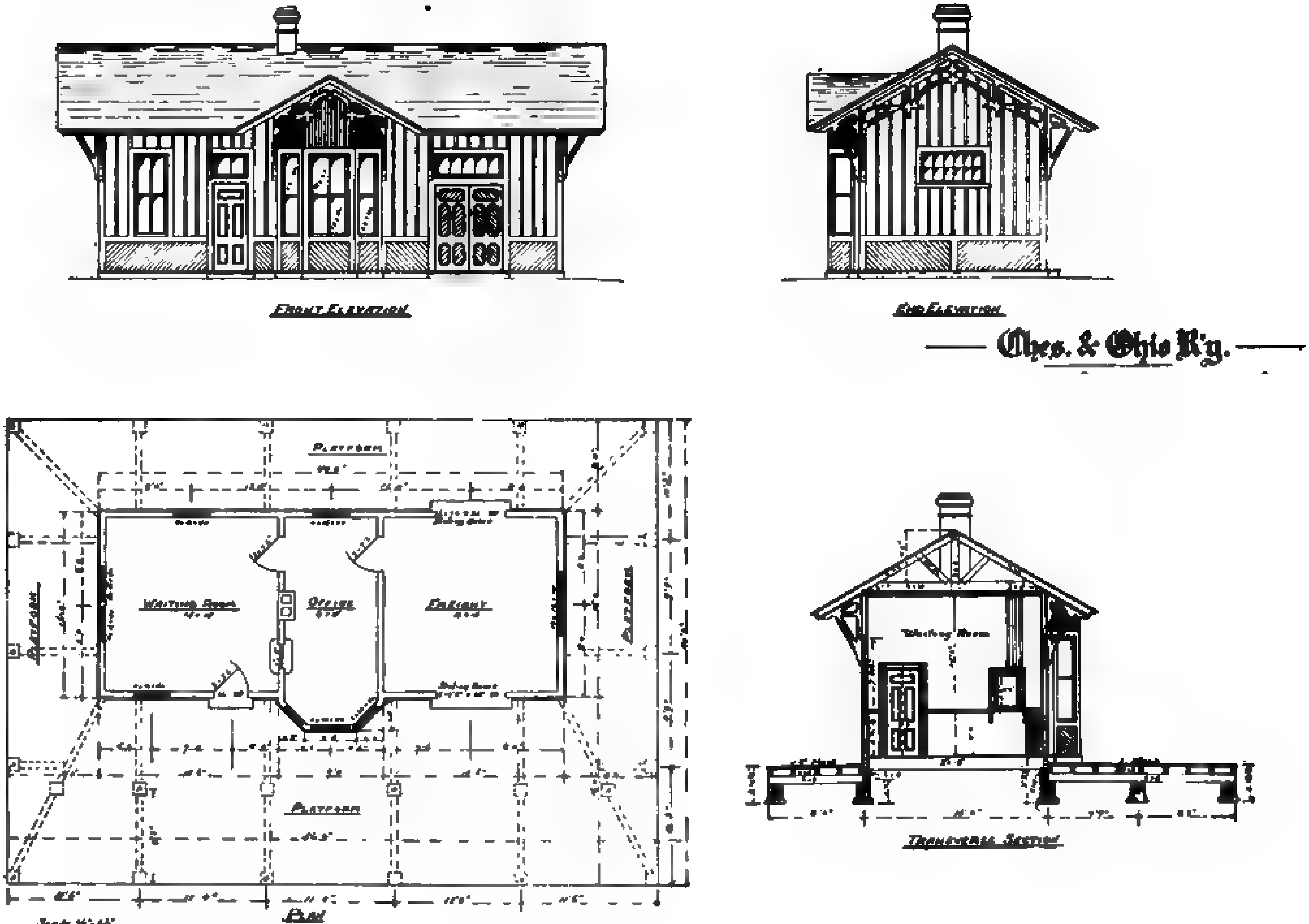
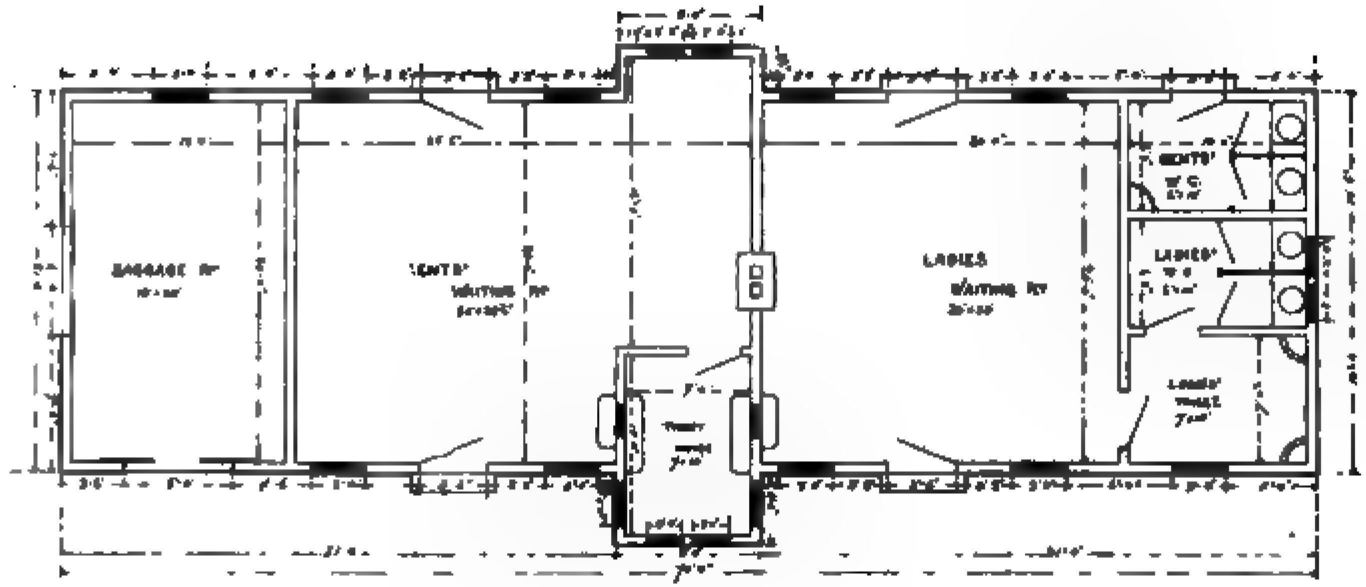


Fig. 25.—Standard Local Combination Depot, No. 2, Chesapeake & Ohio Railway. (Plan No. 14, Committee Report on "Local Stations.")

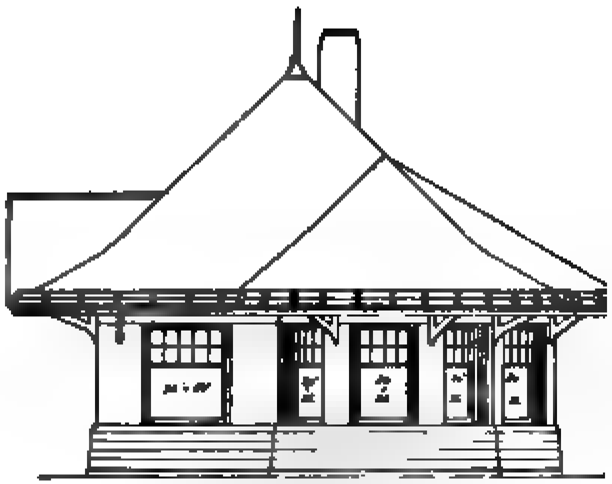
Passenger Station for Pennsylvania Lines West of Pittsburgh



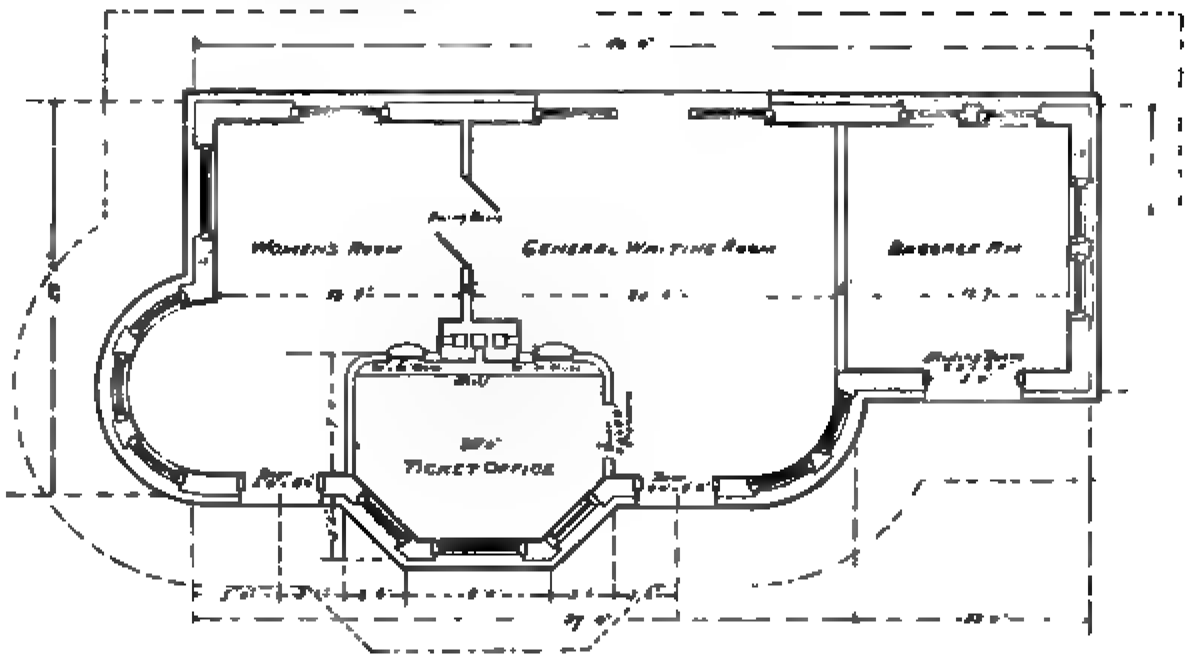
END VIEW

GROUND PLAN

FIG. 26.—Local Passenger Depot, Pennsylvania Lines West of Pittsburgh. (Plan No. 15, Committee Report on "Local Stations")



ELEVATION WEST END



GROUND PLAN

Scale—1-4 inch = 1 foot

REAR ELEVATION

ELEVATION. TRACK SIDE

FIG. 27.—Local Passenger Depot at Southside, O., C., C., C. & St. Louis Railway. (Plan No. 16, Committee Report on "Local Stations.")

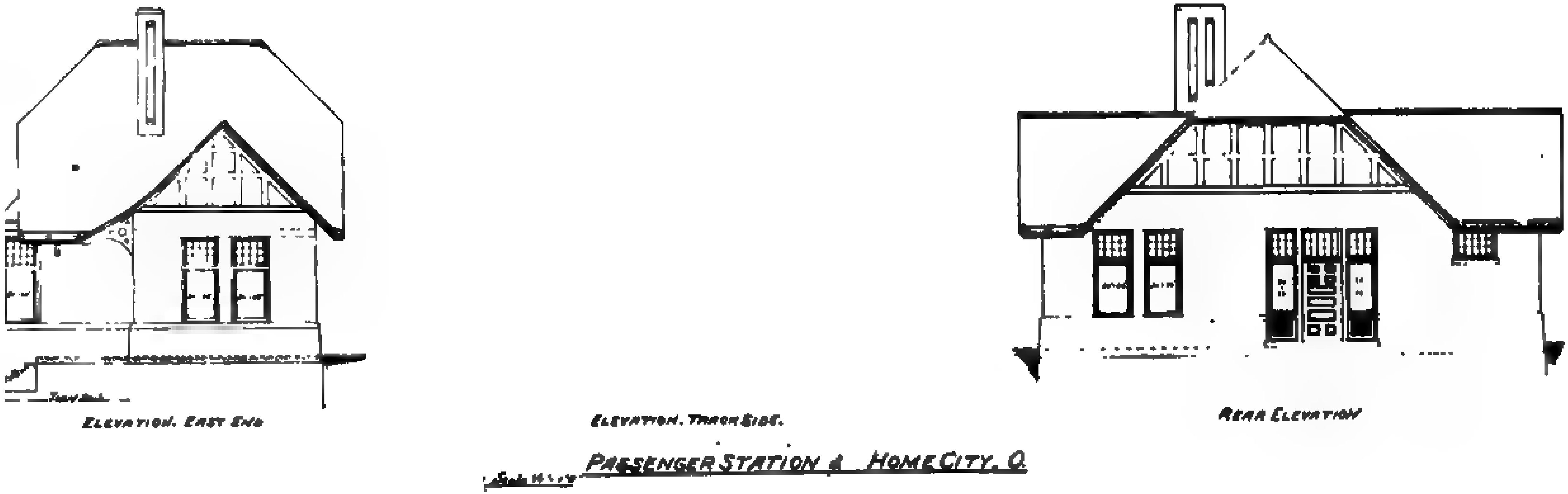
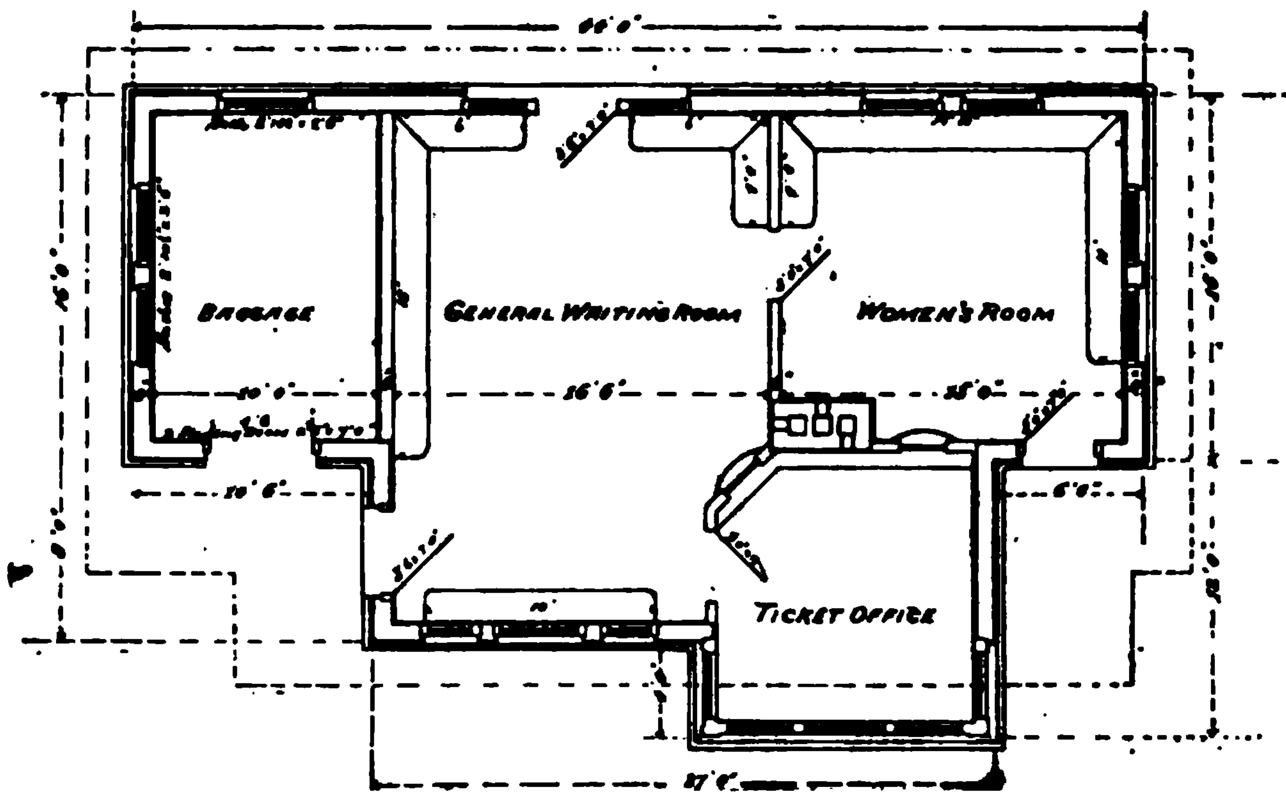
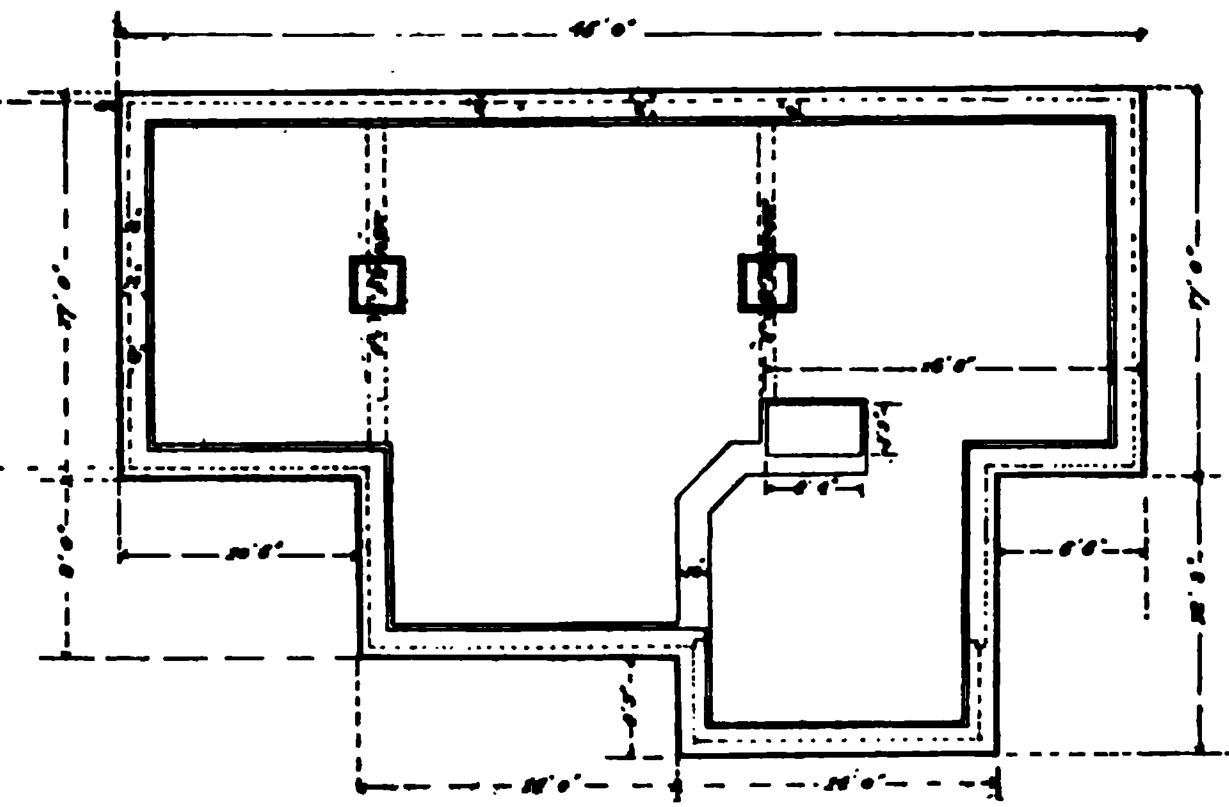


Fig. 28.—Local Passenger Depot at Home City, O., C., C., C. & St. Louis Railway. (Plan No. 17, Committee Report on "Local Stations.")

ELEVATION. WEST END



Ground Plan.



Foundation Plan.

FIG. 29, Plan No. 17.—*Continued.*

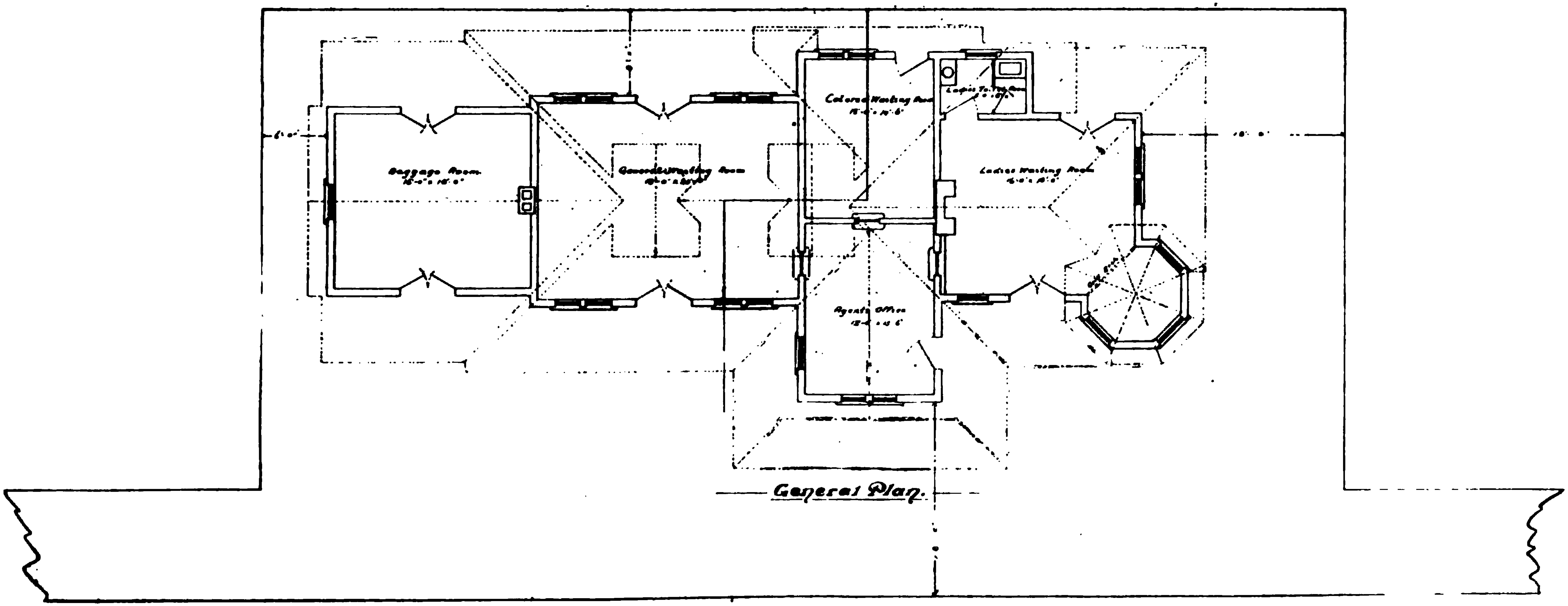


FIG. 30.—Floor Plan of Local Passenger Depot at Richmond, Ky., Louisville and Nashville Railroad. (Plan Nos. 18 and 19, Committee Report on "Local Stations.")

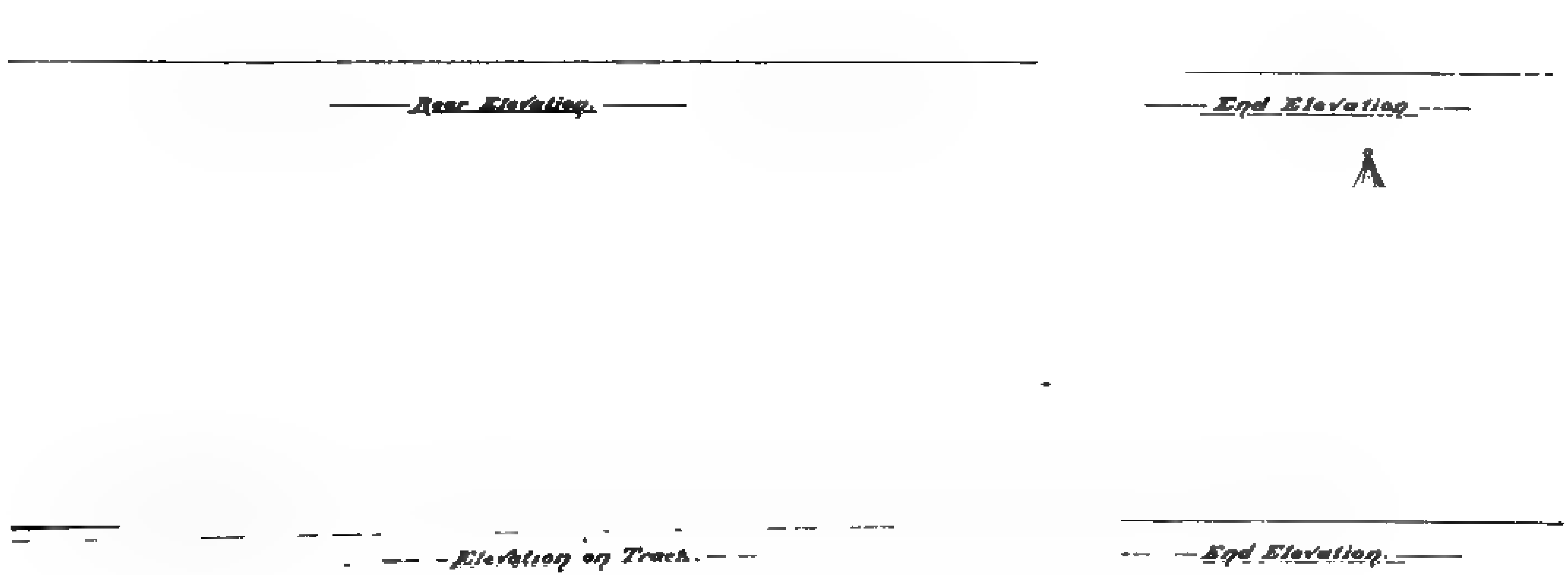


FIG. 31.—Elevations of Local Passenger Depot at Richmond, Ky., Lousville & Nashville Railroad. (Plan Nos. 18 and 19, Committee Report on "Local Stations.")

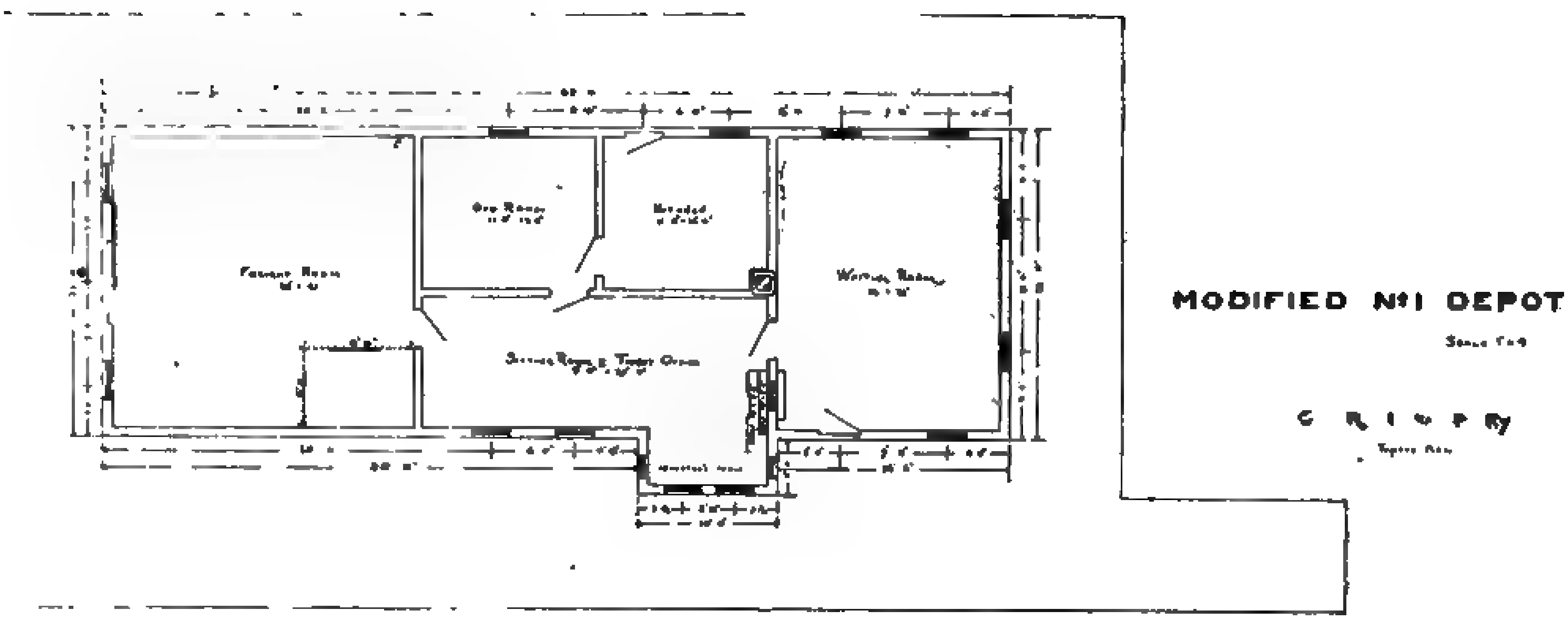


Fig. 82.—Local Combination Depot, No. 1, Chicago, Rock Island & Pacific Railway. (Plan No. 20, Committee Report on Local Stations.")

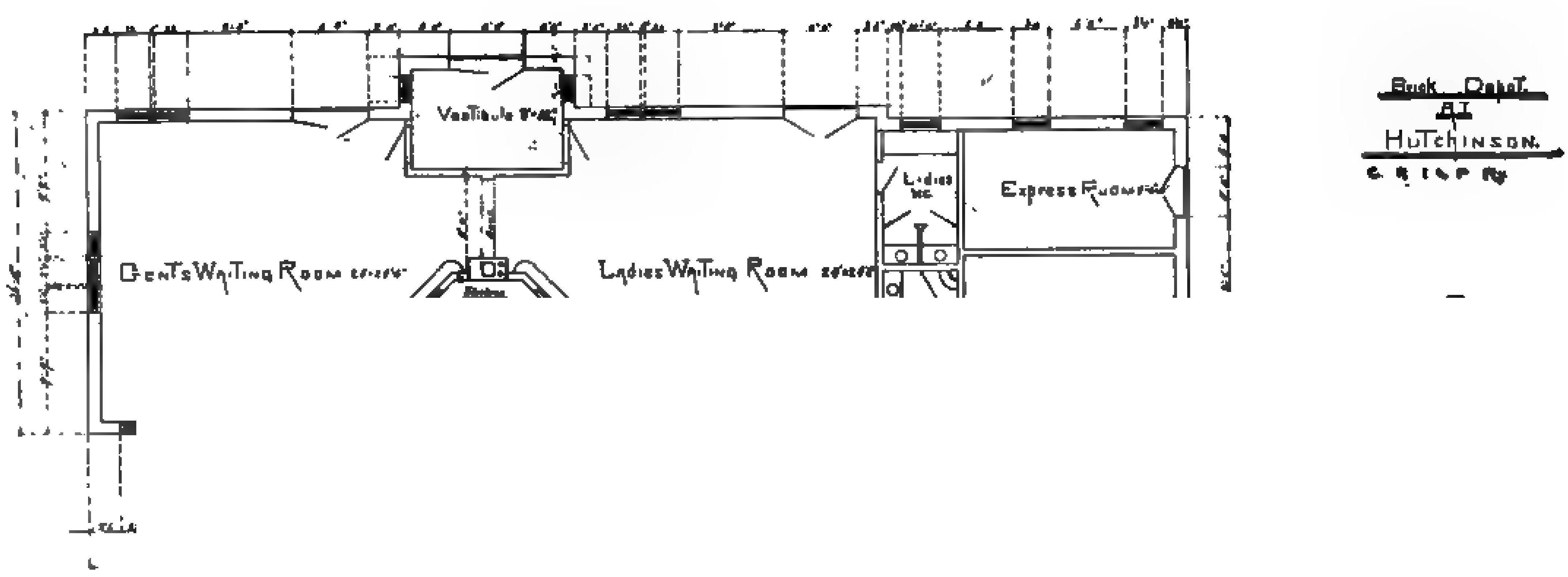


FIG 33—Local Passenger Depot at Hutchinson, Chicago, Rock Island & Pacific Railway. (Plan No. 21. Committee Report on "Local Stations.")

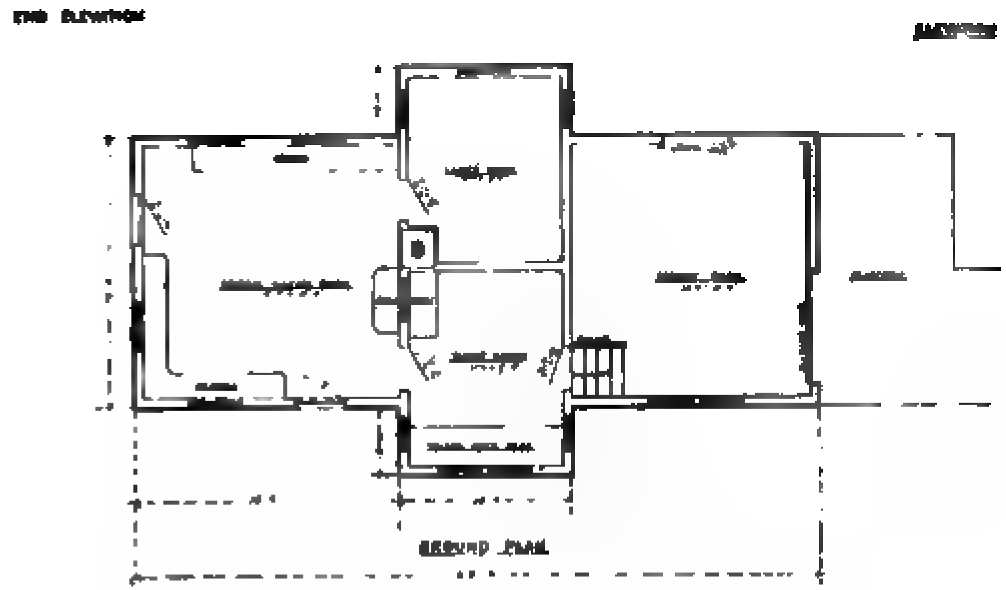


FIG. 84.—Local Combination Depot at King's Creek, O., New York, Lake Erie & Western Railroad. (Plan No. 22, Committee Report on "Local Stations.")

Fig. 85.—Local Passenger Depot at Barberton, O., New York, Lake Erie & Western Railroad. (Plan No. 23, Committee Report on "Local Stations.")

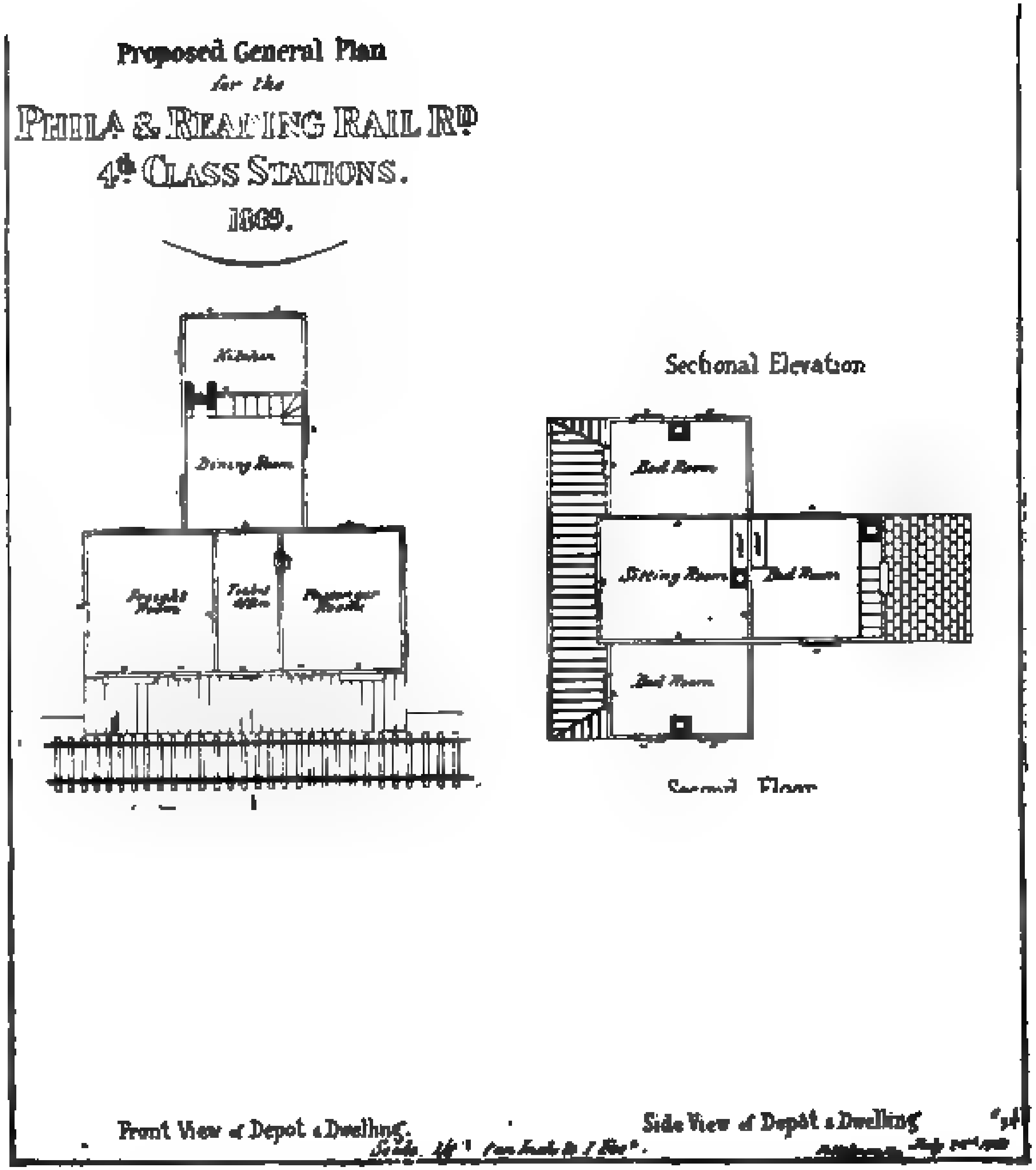
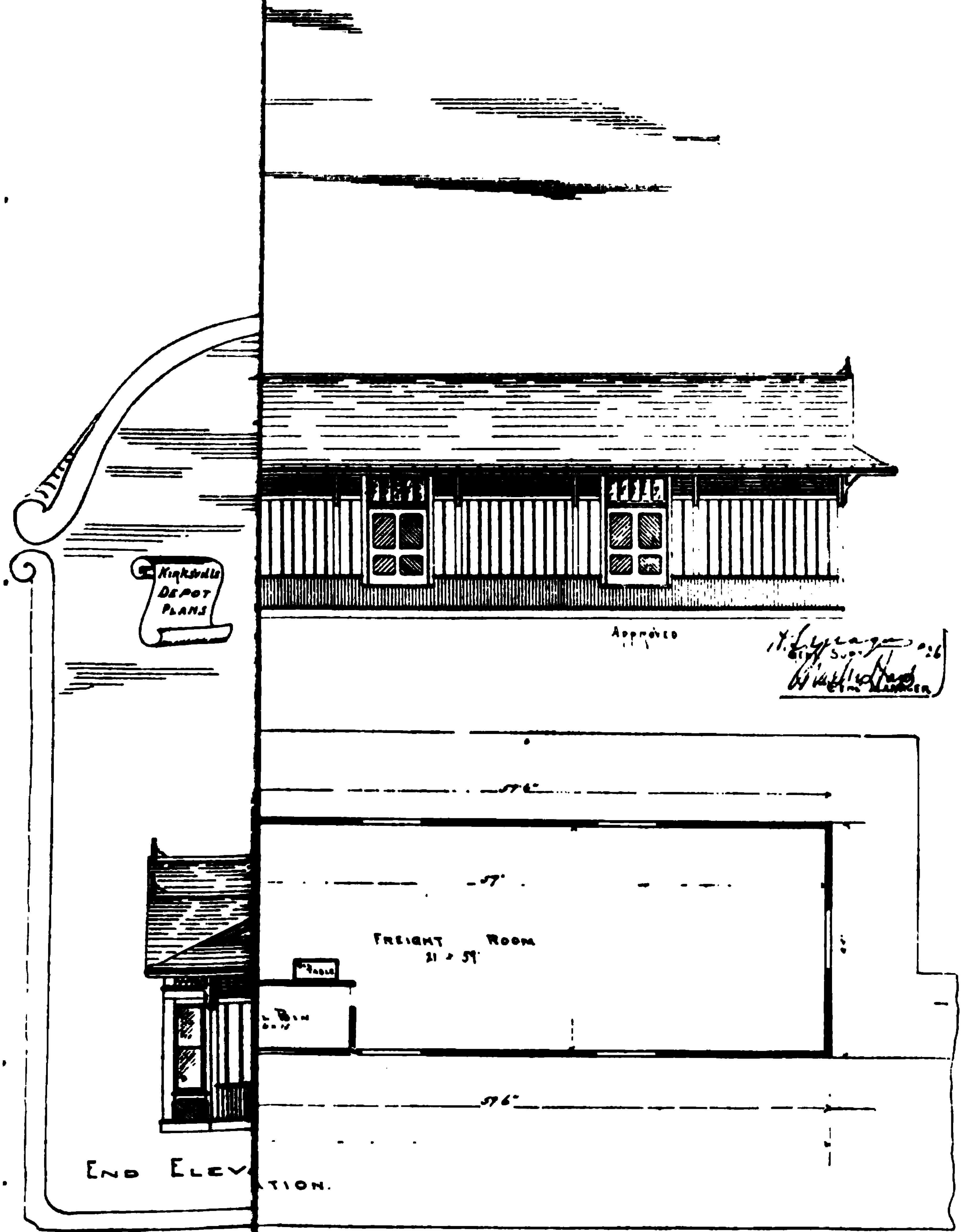


Fig. 98.—Local Fourth Class Combination Depot, Philadelphia & Reading Railroad. Designed in 1869. (Plan No. 94. Committee Report on "Local Stations.")



Kirksville
DEPOT
PLANS
Approved
57'6"
57'
FREIGHT ROOM
21 x 59
57'6"
END ELEVATION.

s.")

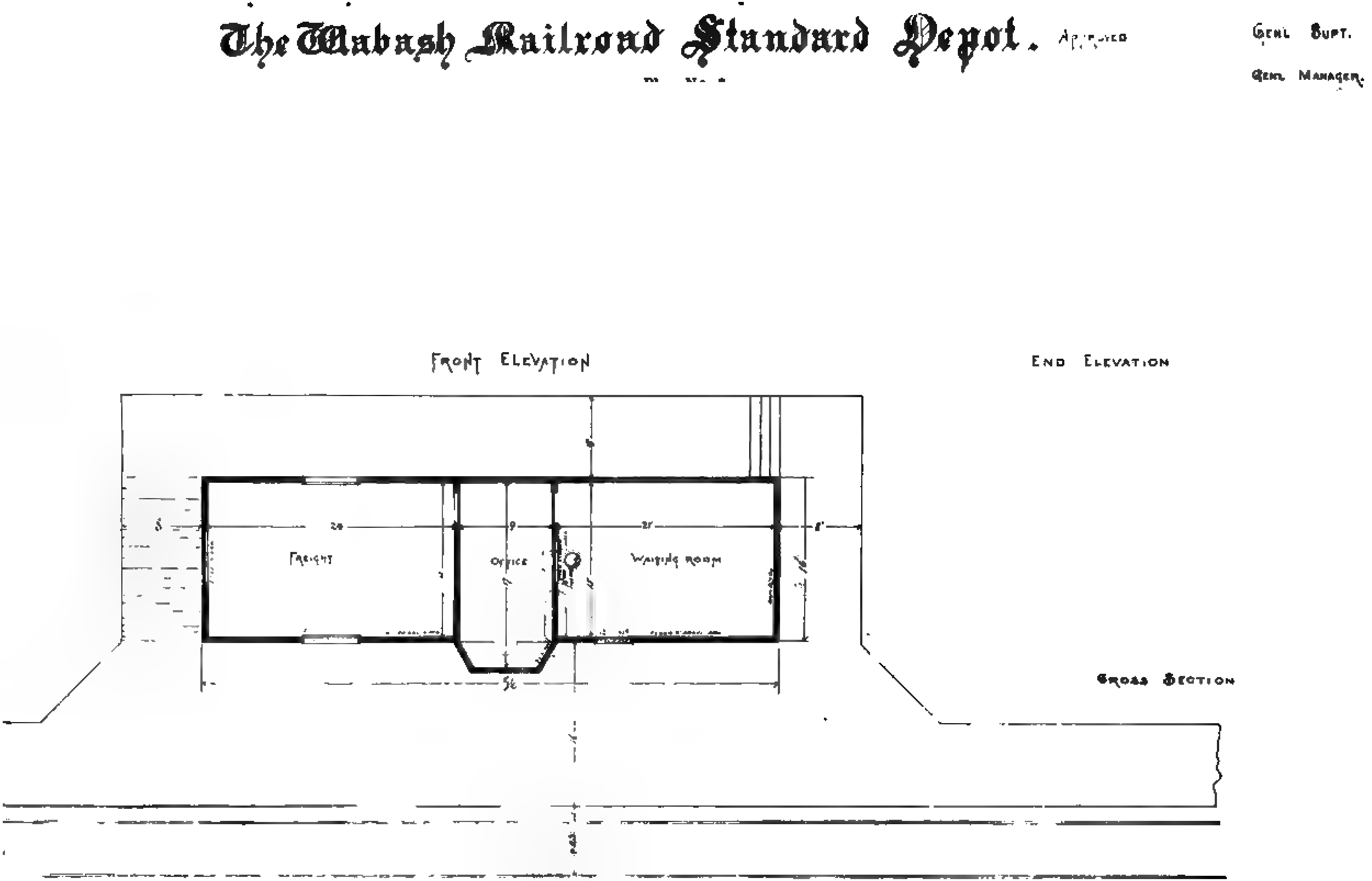


Fig. 39.—Standard Local Combination Depot, Wabash Railroad. (Plan No. 27, Committee Report on "Local Stations.")

Fig. 40. Local Passenger Depot at Seabrook, Boston & Maine Railroad. (Plan No. 28, Committee Report on "Local Stations.")

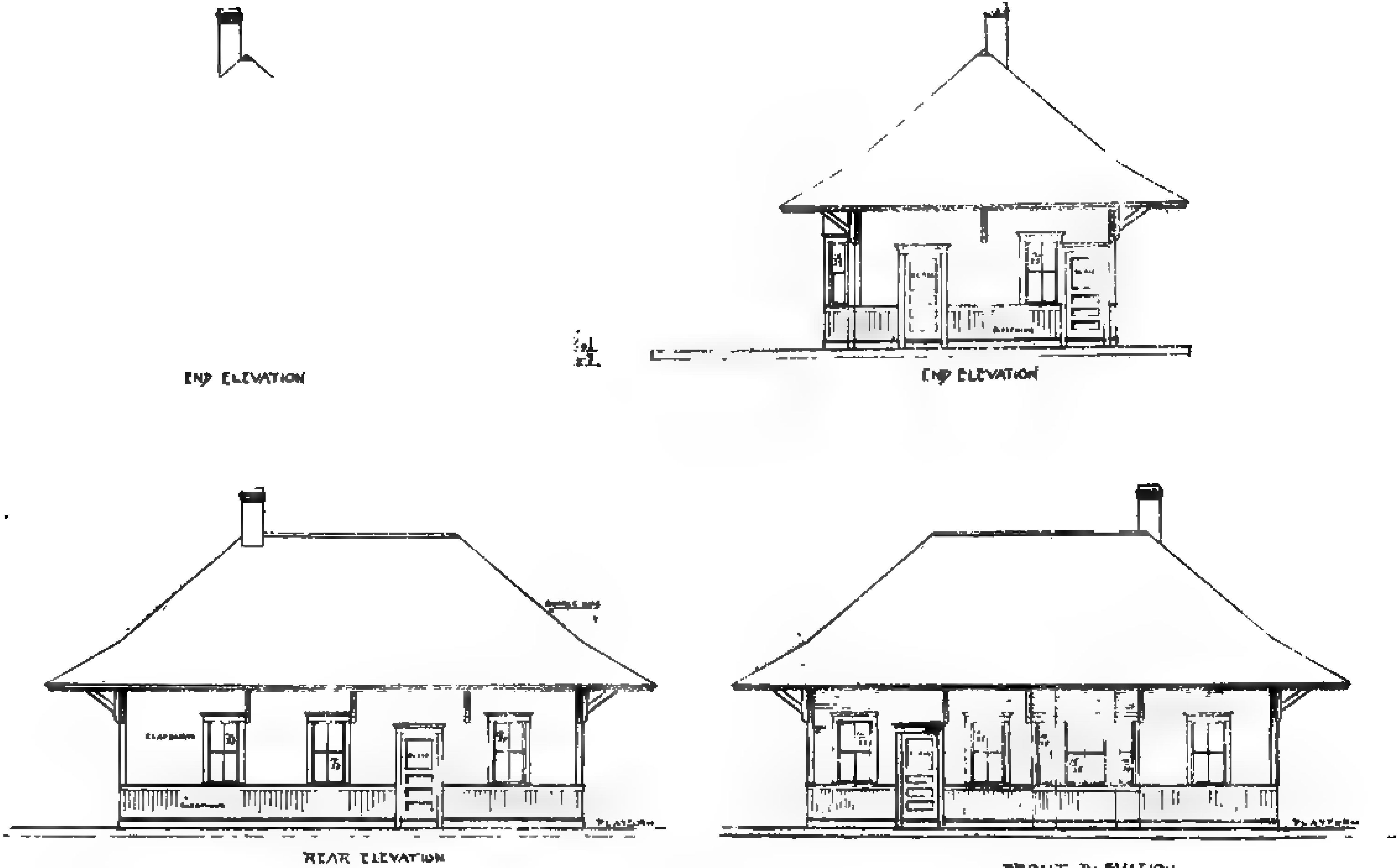


FIG. 41.—Local Passenger Depot at Walnut Hill, Mass., Boston & Maine Railroad. (Plan No. 29, Committee Report on "Local Stations.")

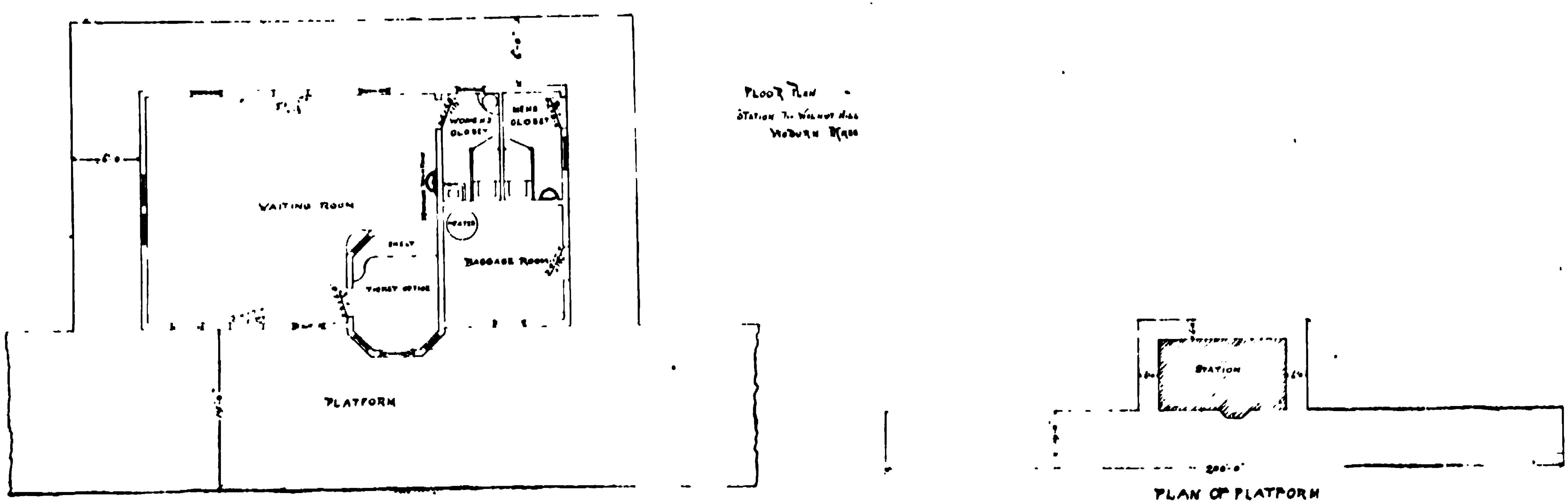


Fig. 42, Plan No. 29.—*Continued.*

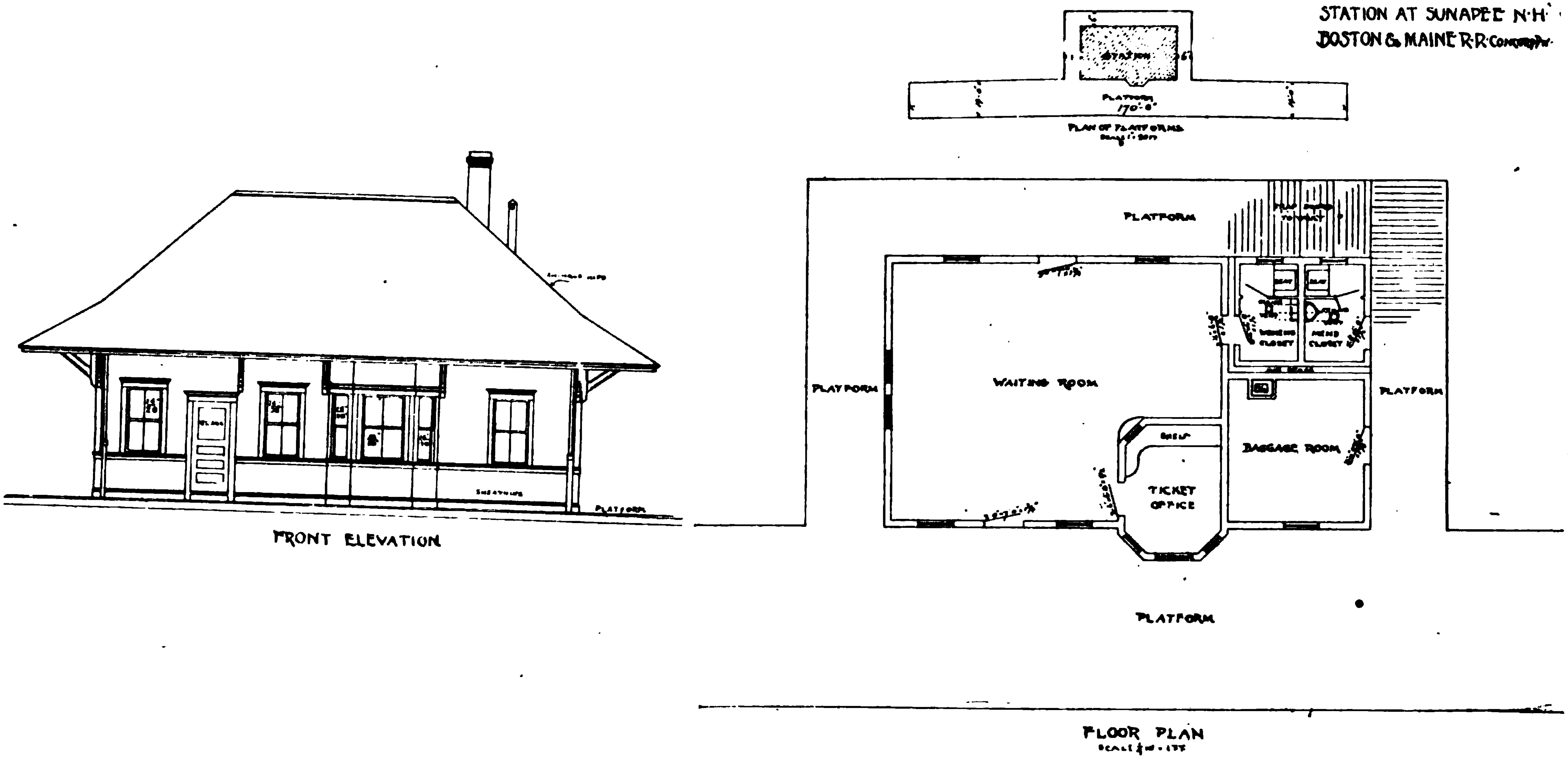


FIG. 43.—Local Passenger Depot at Sunapee, N. H., Boston & Maine Railroad. (Plan No. 30, Committee Report on "Local Stations.")

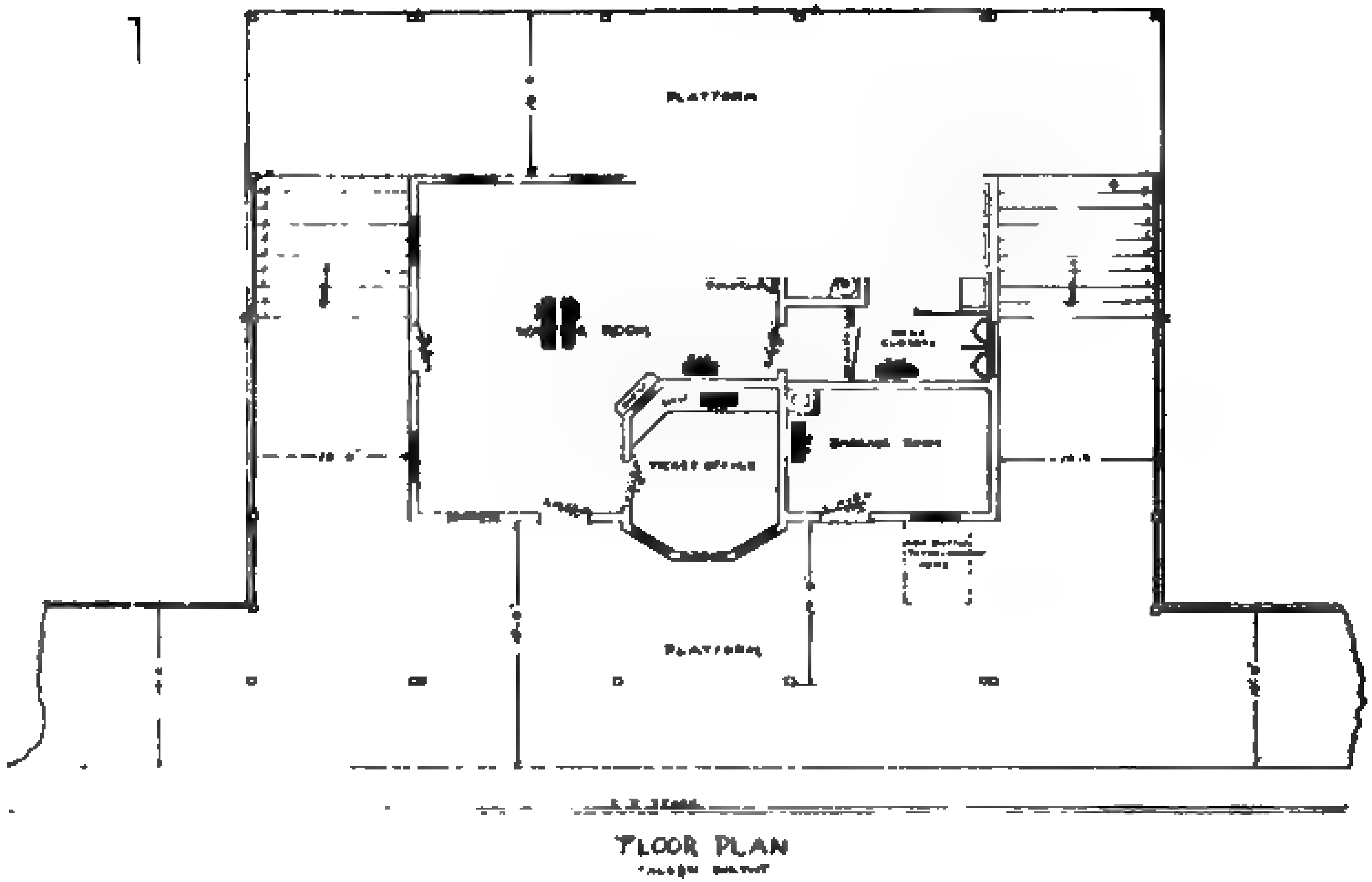


FIG. 44. Local Passenger Depot at West Manchester, Mass. (Plan No 21, Committee Report on "Local Stations.")

FIG. 45.—Local Passenger Depot at Manchester, Mass., Boston & Maine Railroad. (Plan No 22, Committee Report on "Local Stations.")

Front Elevation on Track

Rear Elevation

FIG 46.– Elevations Local Passenger Depot at San Carlos, Southern Pacific Railroad. (Plan No. 33, Committee Report on "Local Stations.")

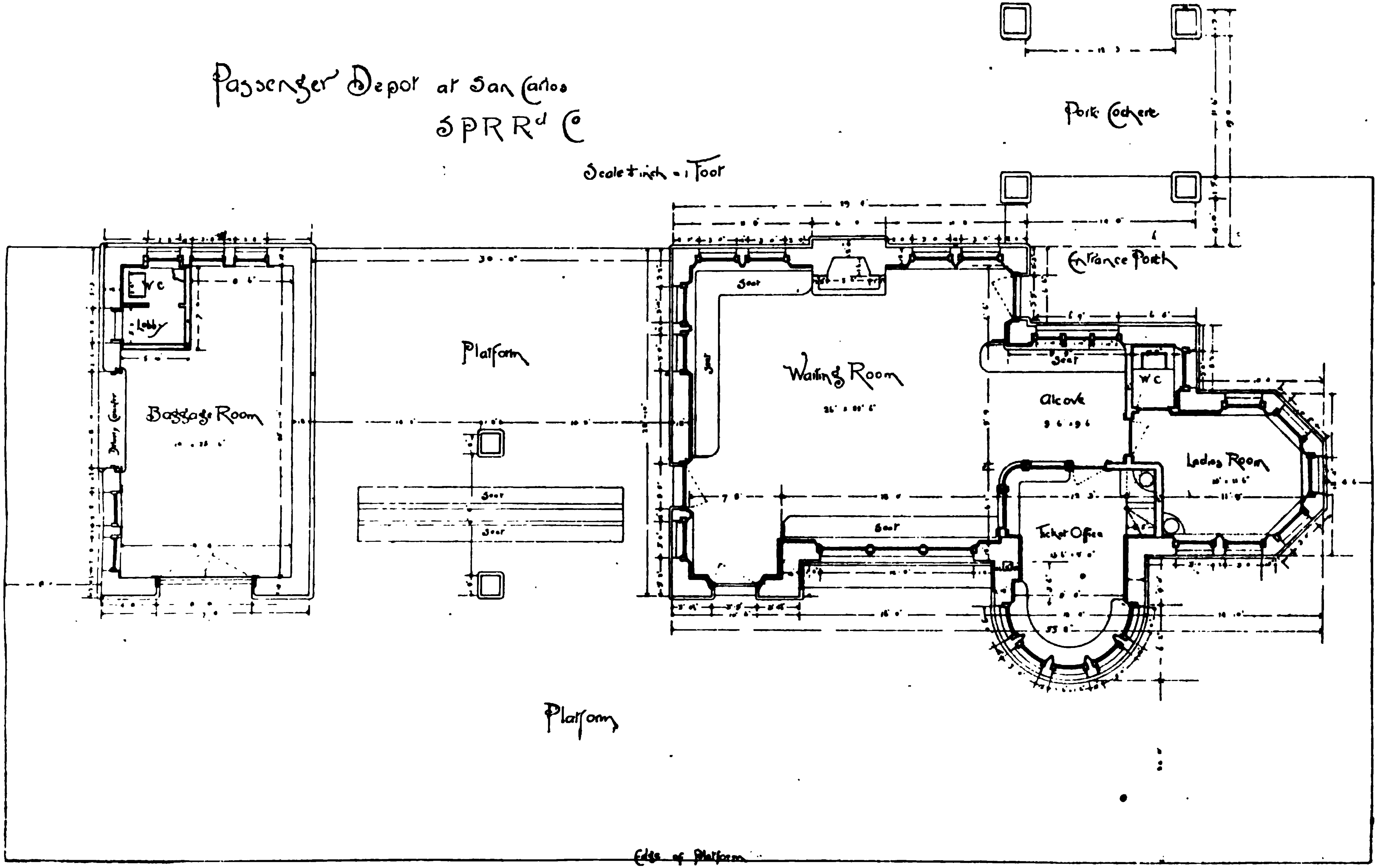
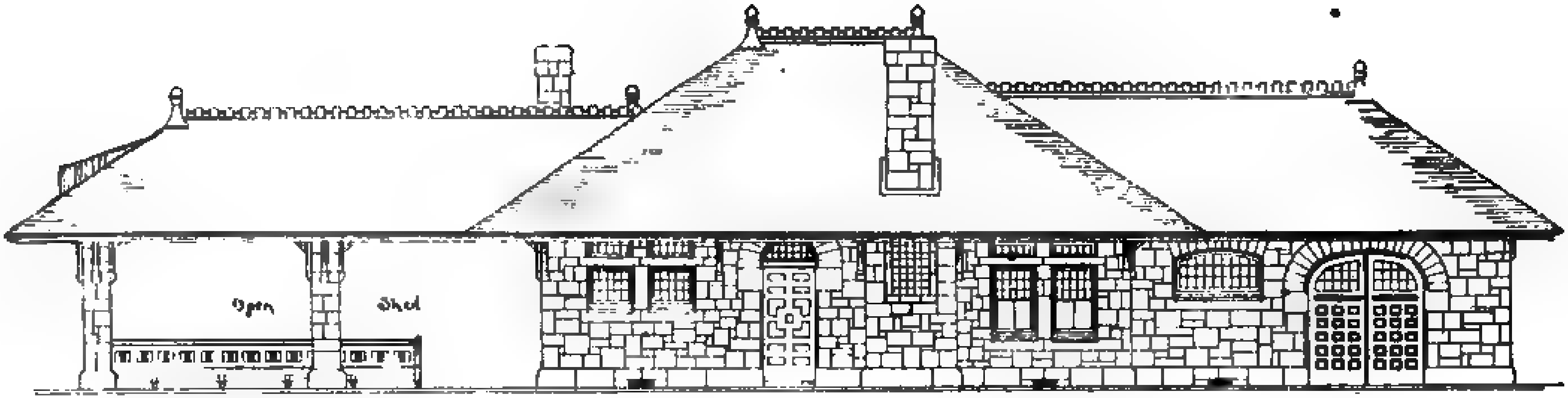


FIG. 47.—Ground Plan Local Passenger Depot at San Carlos, Southern Pacific Railroad. (Plan No. 33, Committee Report on "Local Stations.")



Front Elevation on Track

FIG. 48.—Elevations of Local Passenger Depot at Los Guilucos, Southern Pacific Railroad. (Plan No. 34, Committee Report on "Local Stations.")

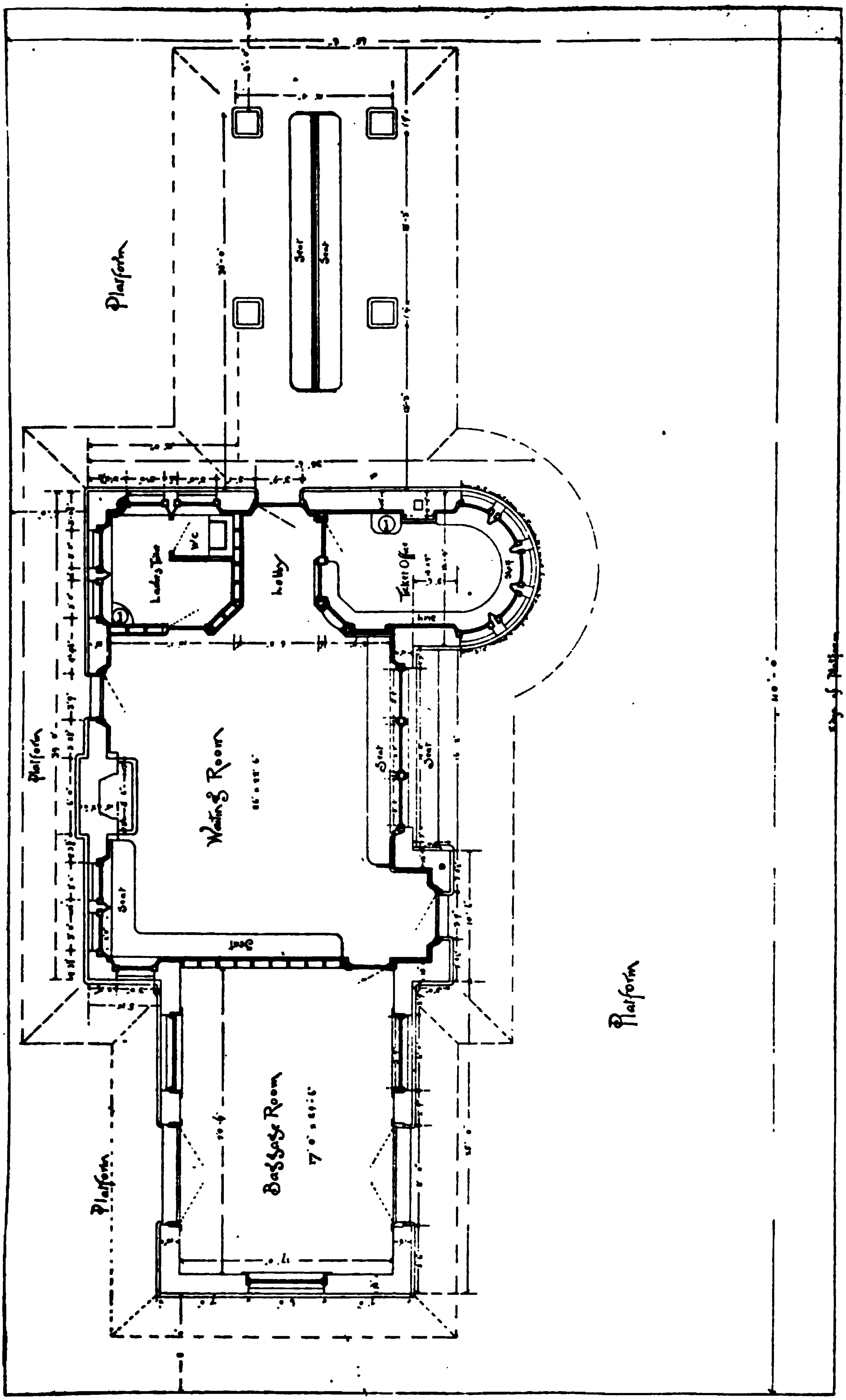


FIG. 49.—Ground Plan of Local Passenger Depot at Los Guilucos, Southern Pacific Railroad. (Plan No. 34, Committee Report on "Local Stations.")

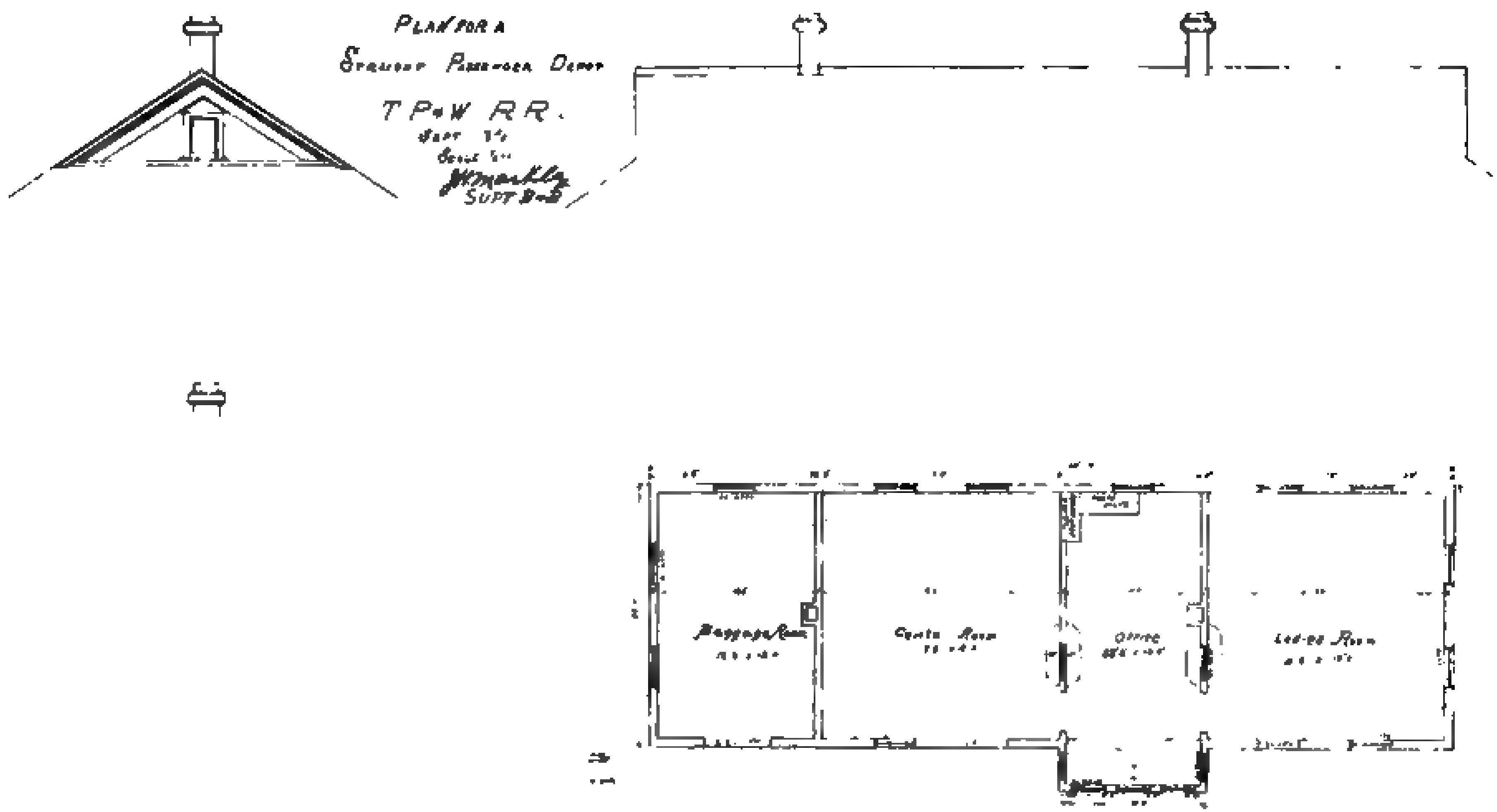


FIG. 58.—Local Passenger Depot, Toledo, Peoria & Western Railroad. (Plan No. 25, Committee Report on "Local Stations.")

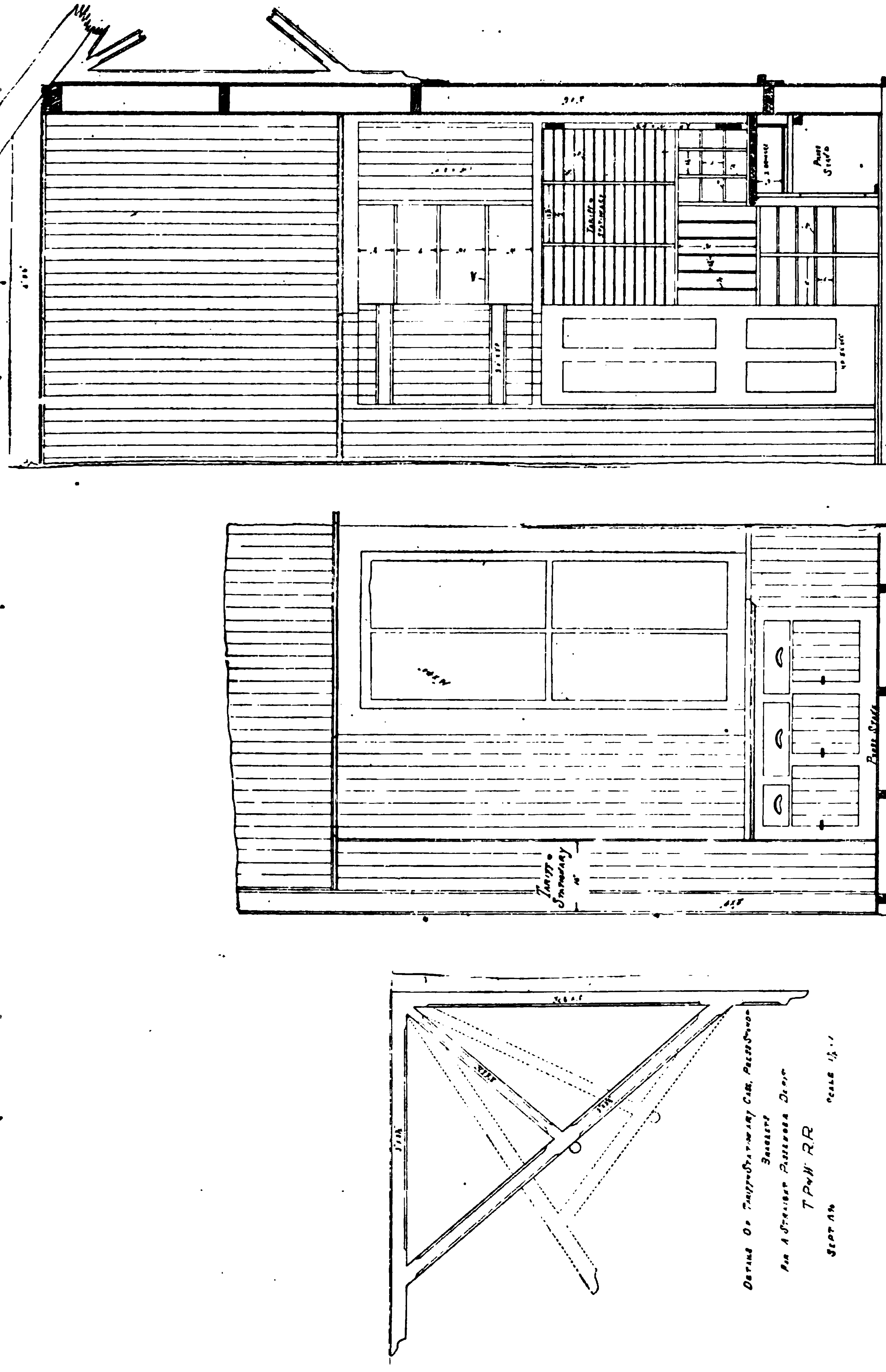


Fig. 51.—Details of Tariff and Stationery Case, Press Stand and Brackets, for Local Passenger Depot, Toledo, Peoria & Western Railroad. (Plan No. 35, Committee Report on "Local Stations.")

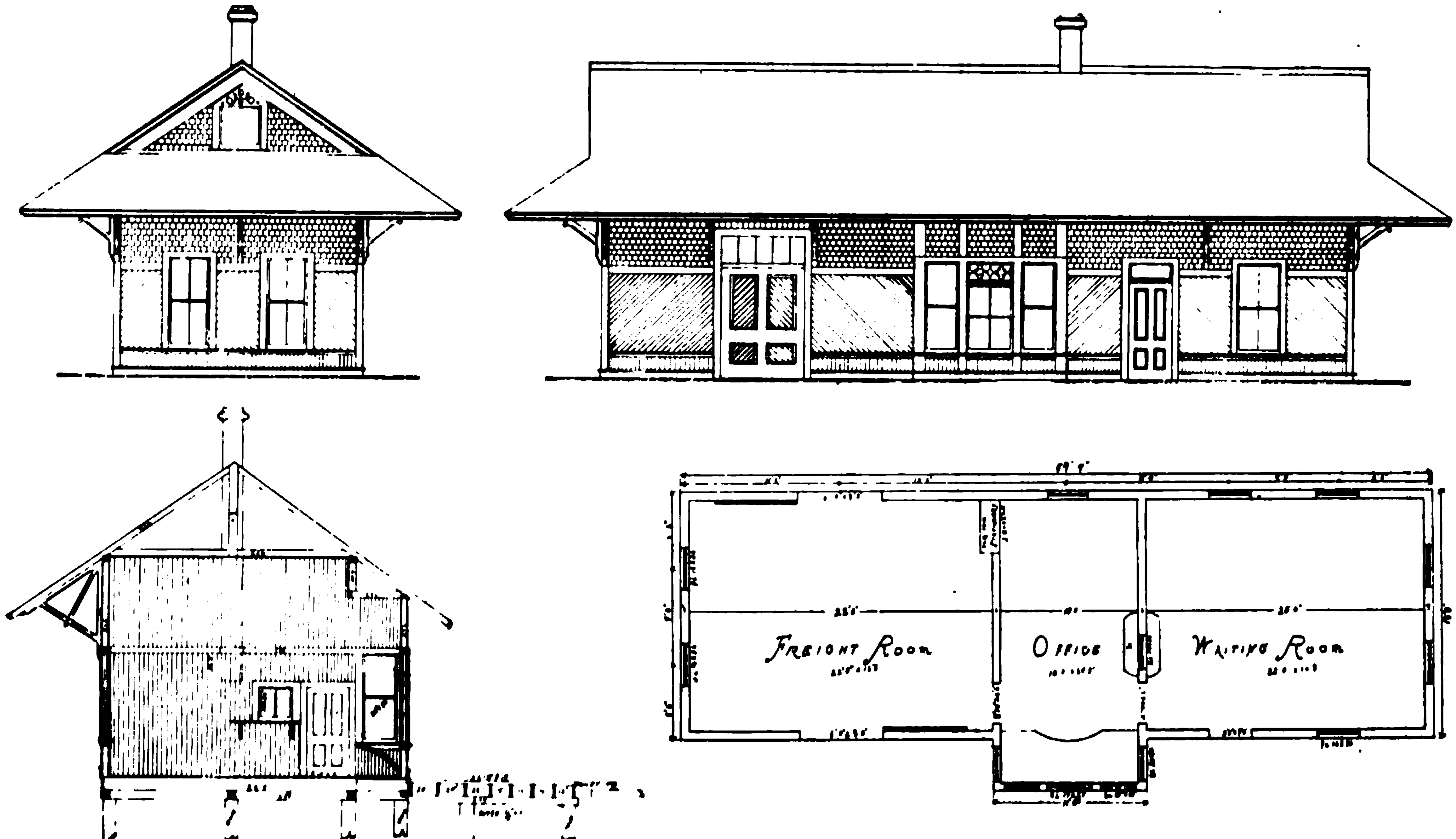


Fig. 52.—Local Combination Depot No. 1, Toledo, Peoria & Western Railroad. (Plan No. 36, Committee Report on "Local Stations.")

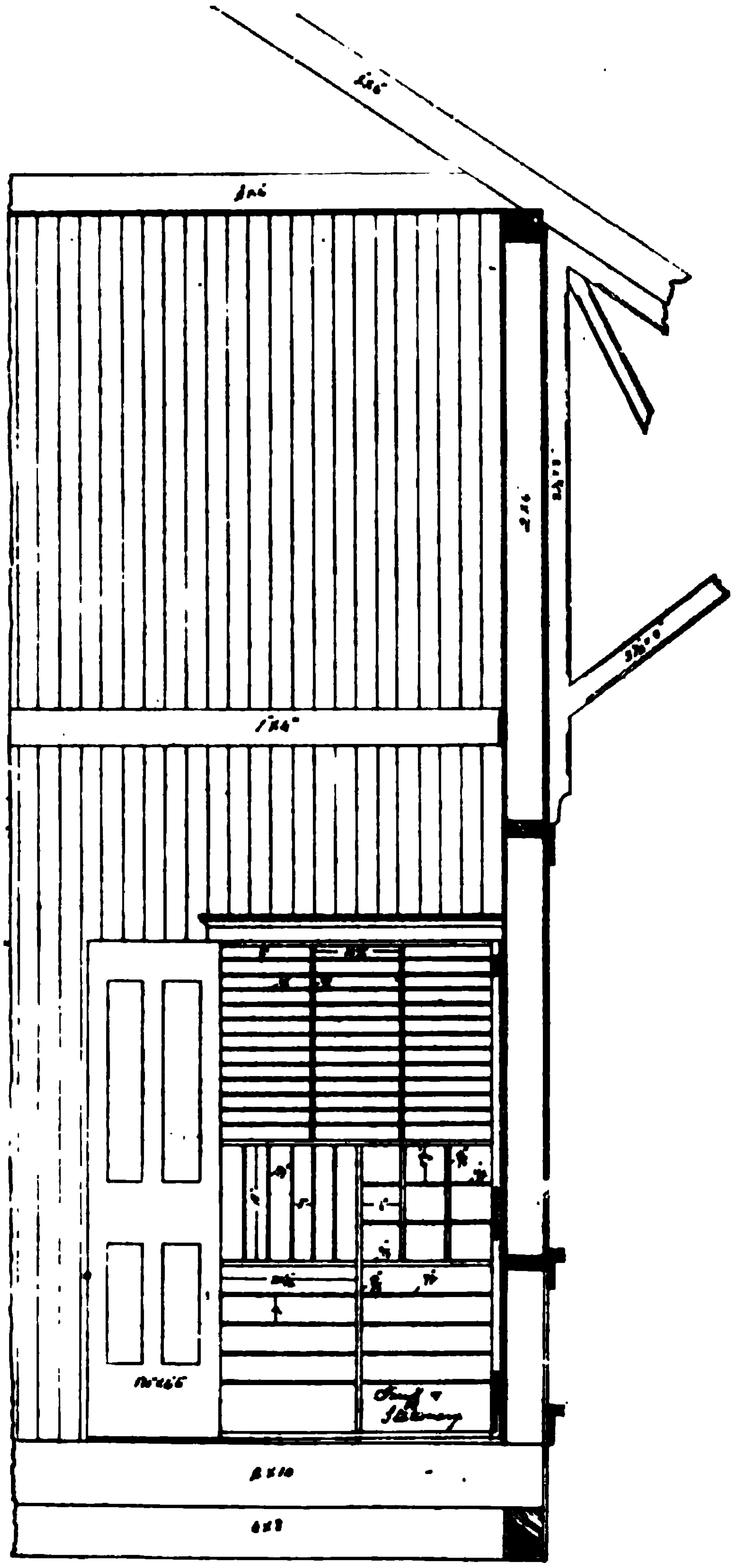


FIG. 58. — Details of Tariff and Stationery Case for Local Combination Depot No. 1, Toledo, Peoria & Western Railroad. (Plan No. 36, Committee Report on "Local Stations.")

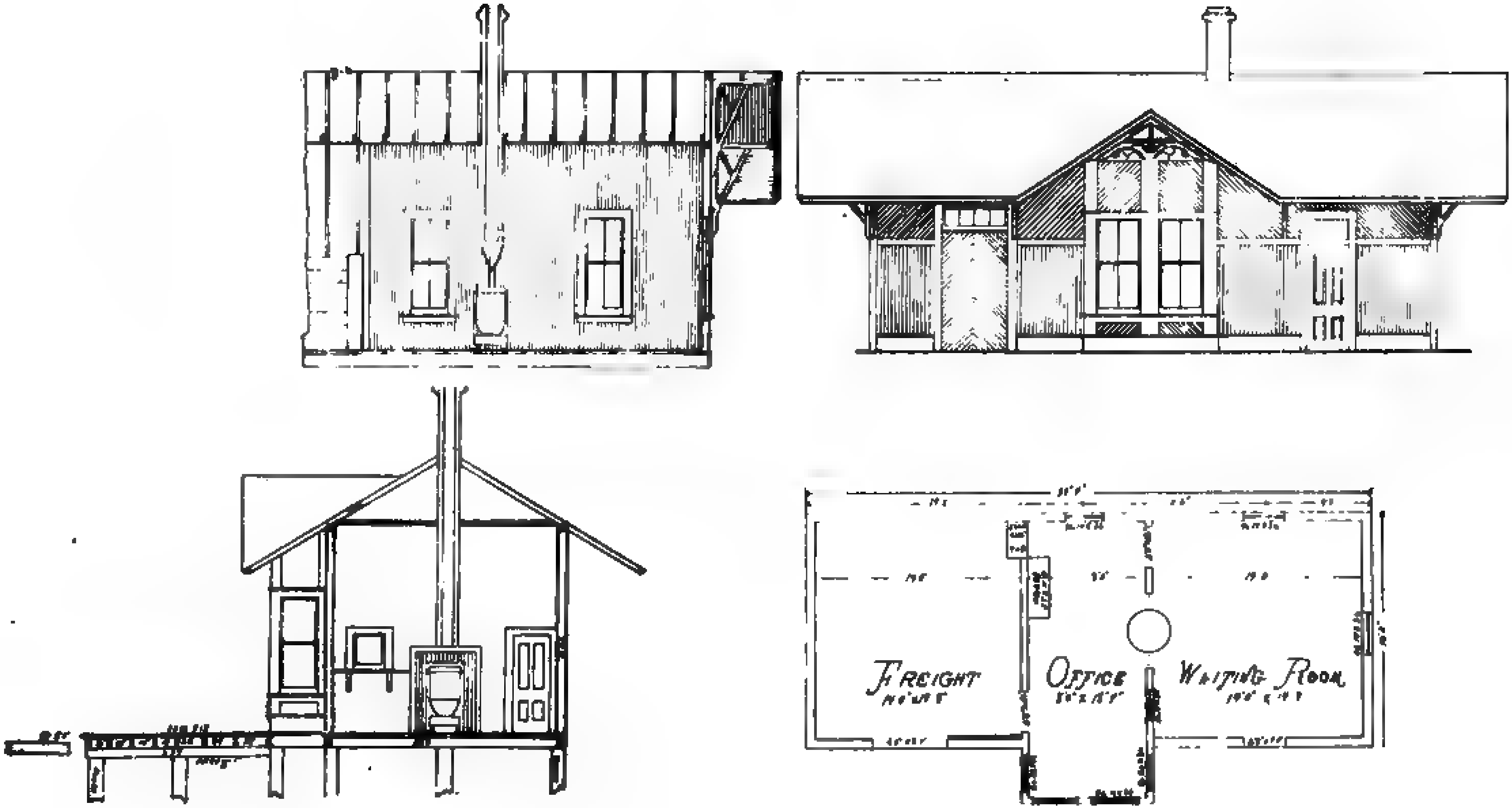


FIG. 54.—Local Combination Depot No. 2, Toledo, Peoria & Western Railroad. (Plan No. 37, Committee Report on "Local Stations.")

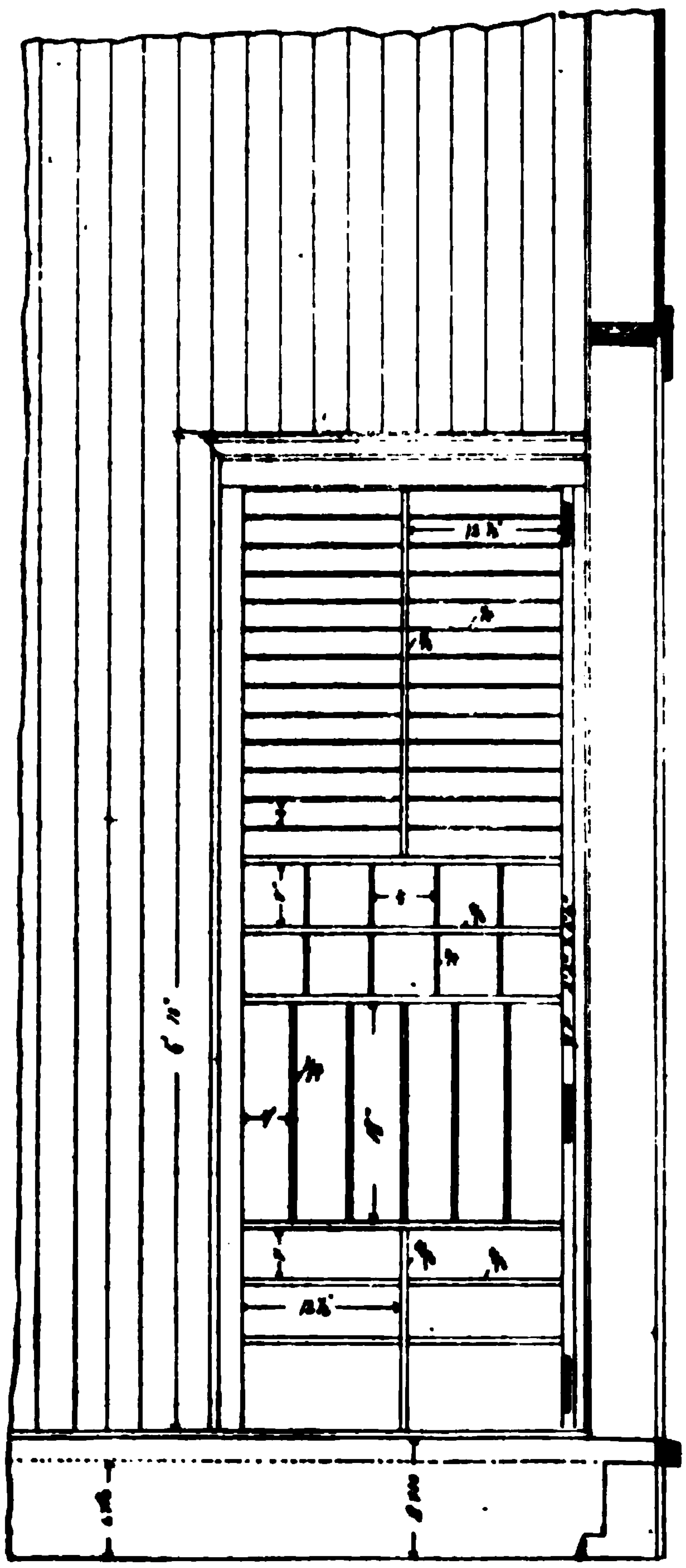


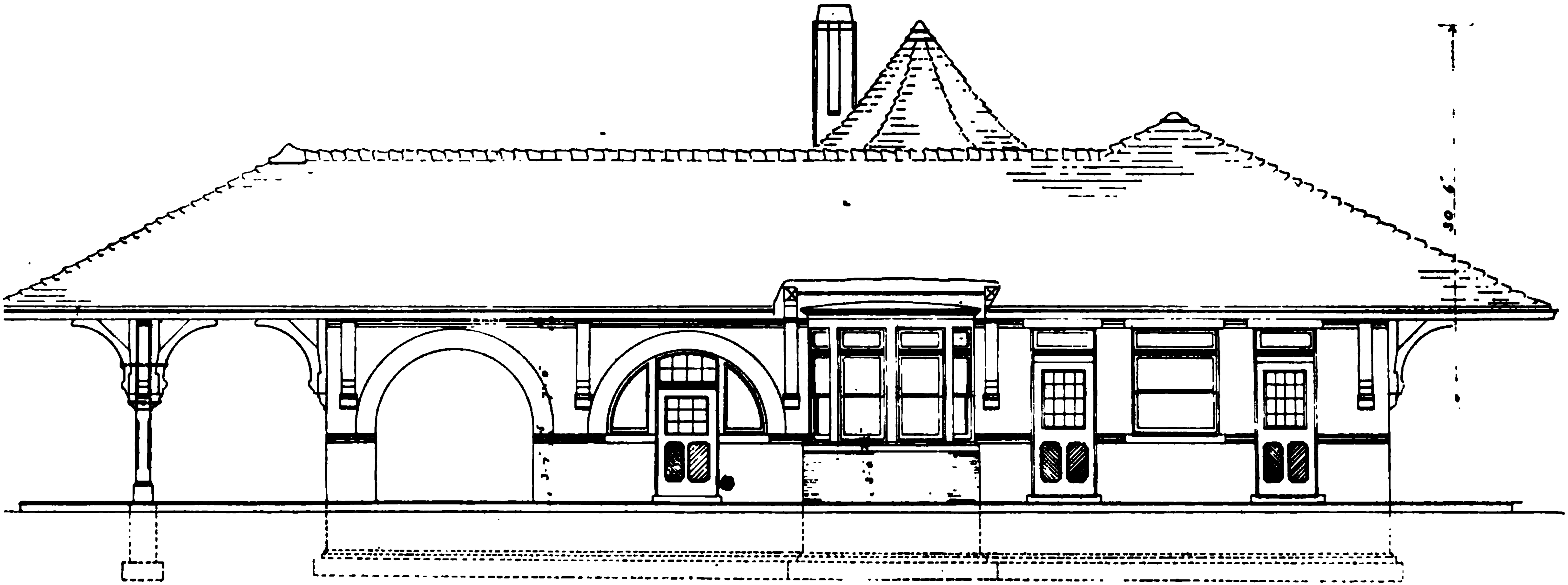
FIG. 55.—Details of Tariff and Stationery Case for Local Combination Depot No. 2, Toledo, Peoria & Western Railroad. (Plan No. 37, Committee Report on "Local Stations.")

Rear Side Elevation

FIG. 86.—Elevations of Local Passenger Depot at Glen Cove, L. I., Long Island Railroad (Plan No. 28, Committee Report on "Local stations.")

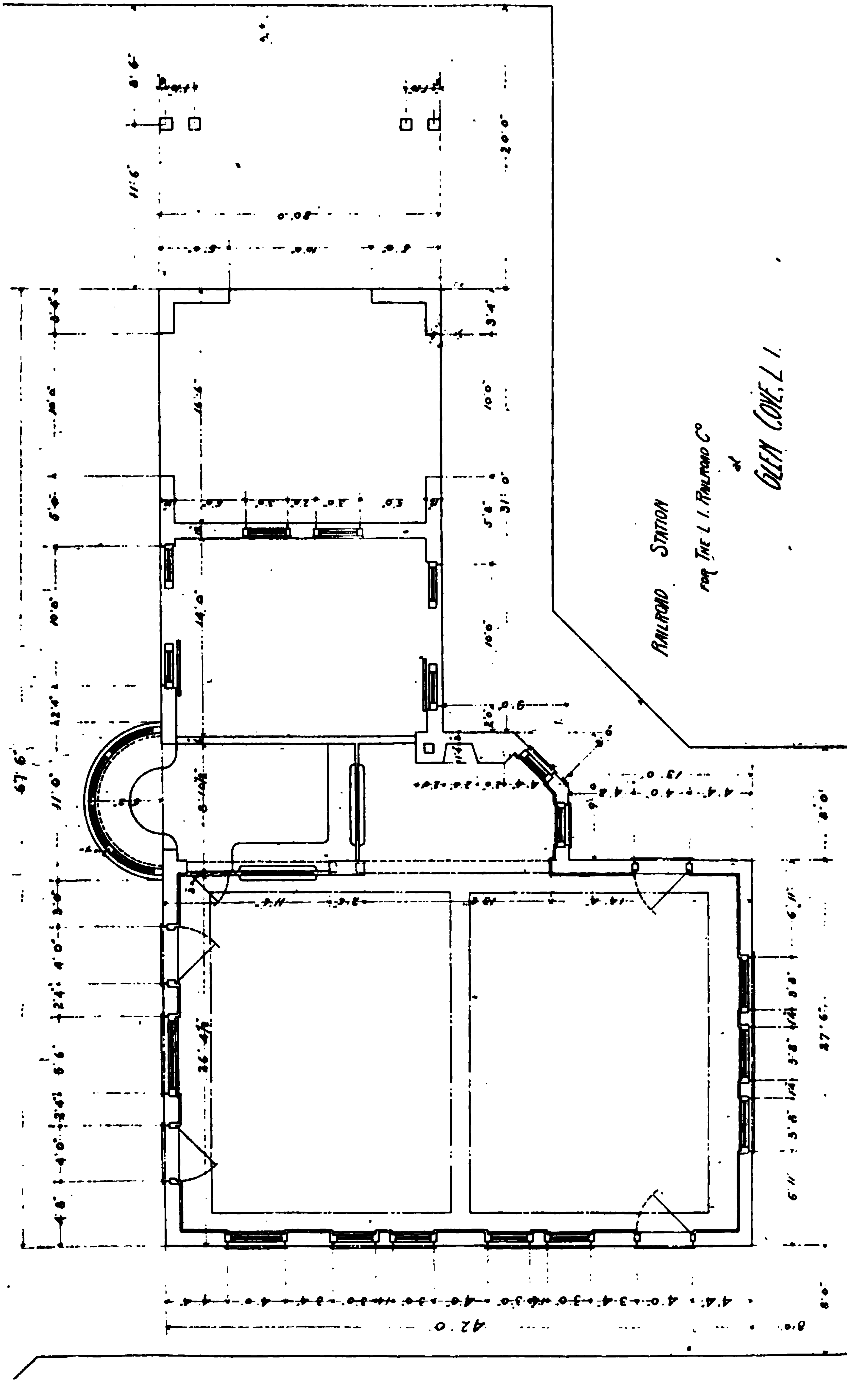
Longitudinal Section.

Fig. 57.—Longitudinal Section of Local Passenger Depot at Glen Cove, L. I., Long Island Railroad. (Plan No. 28, Committee Report on "Local Stations.)



Track Side Elevation.

Fig. 58.—Track Side Elevation of Local Passenger Depot at Glen Cove, L. I., Long Island Railroad. (Plan No. 38, Committee Report on "Local Stations.")



First Story Plan.

FIG. 58.—Ground Plan of Local Passenger Depot at Glen Cove, L. I., Long Island Railroad. (Plan No. 38, Committee Report on "Local Stations.")

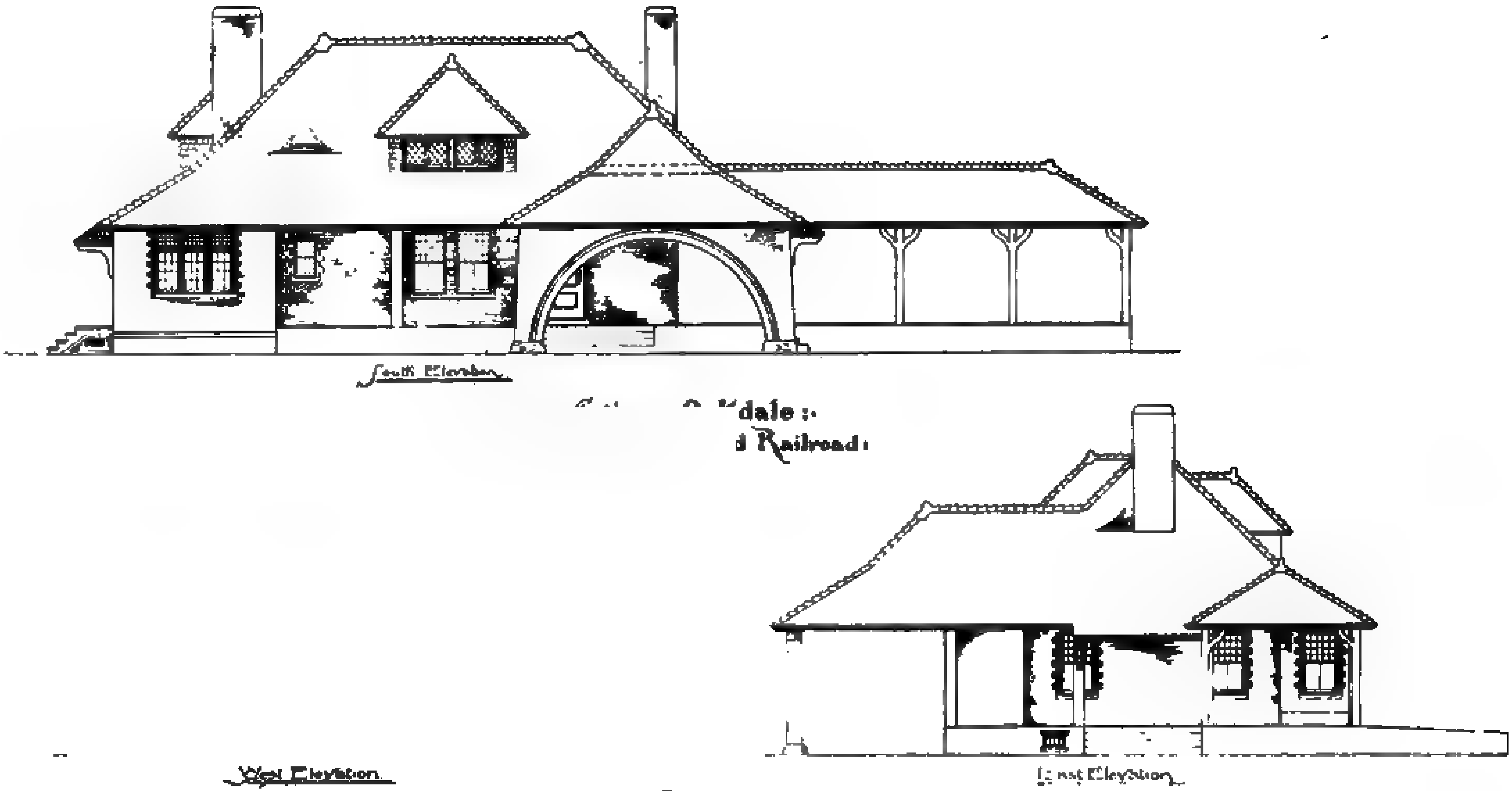


Fig. 60.—Elevations of Local Passenger Depot at Oakdale, Long Island Railroad. (Plan No. 20, Committee Report on "Local Stations.")

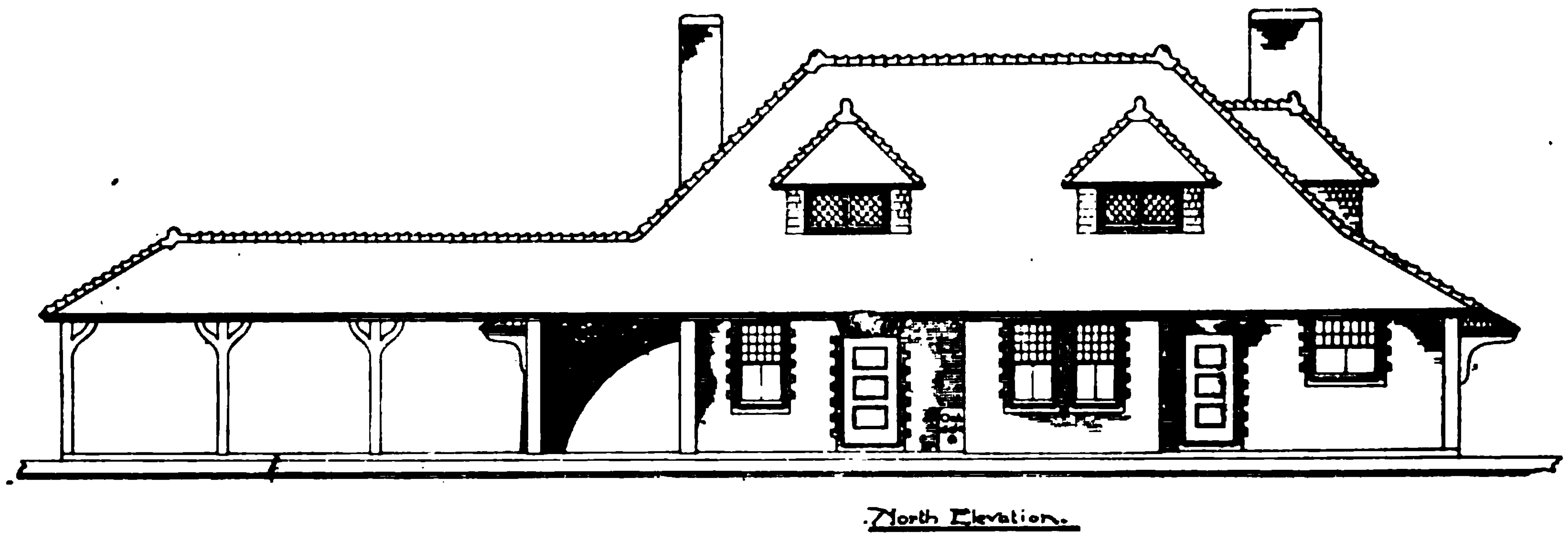


FIG. 61.—Track side Elevation of Local Depot at Oakdale, Long Island Railroad. (Plan No. 39, Committee Report on "Local Stations.")

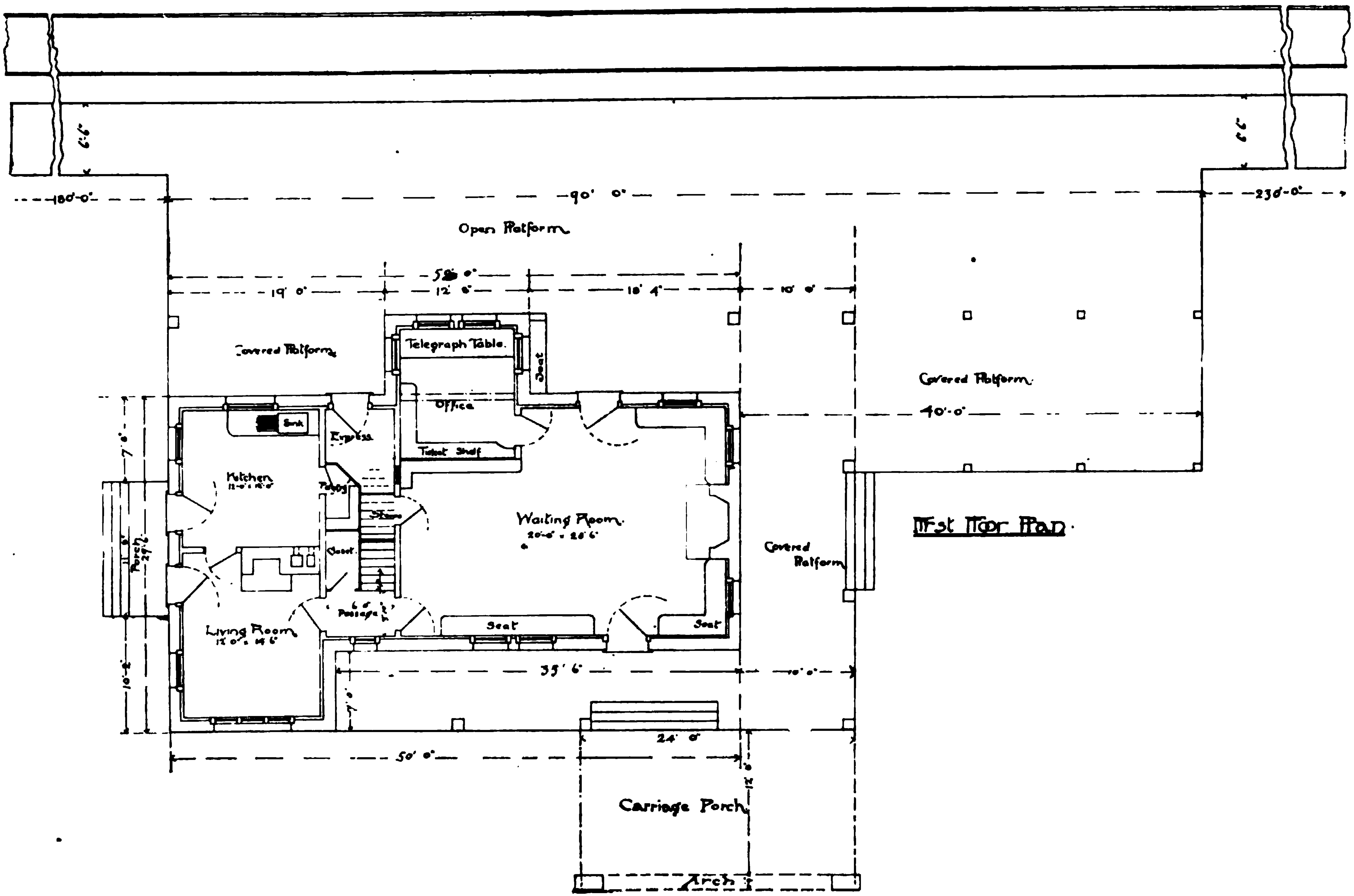


Fig. 62.—Ground Floor Plan of Local Passenger Depot at Oakdale, Long Island Railroad. (Plan No. 39, Committee Report on "Local Stations.")

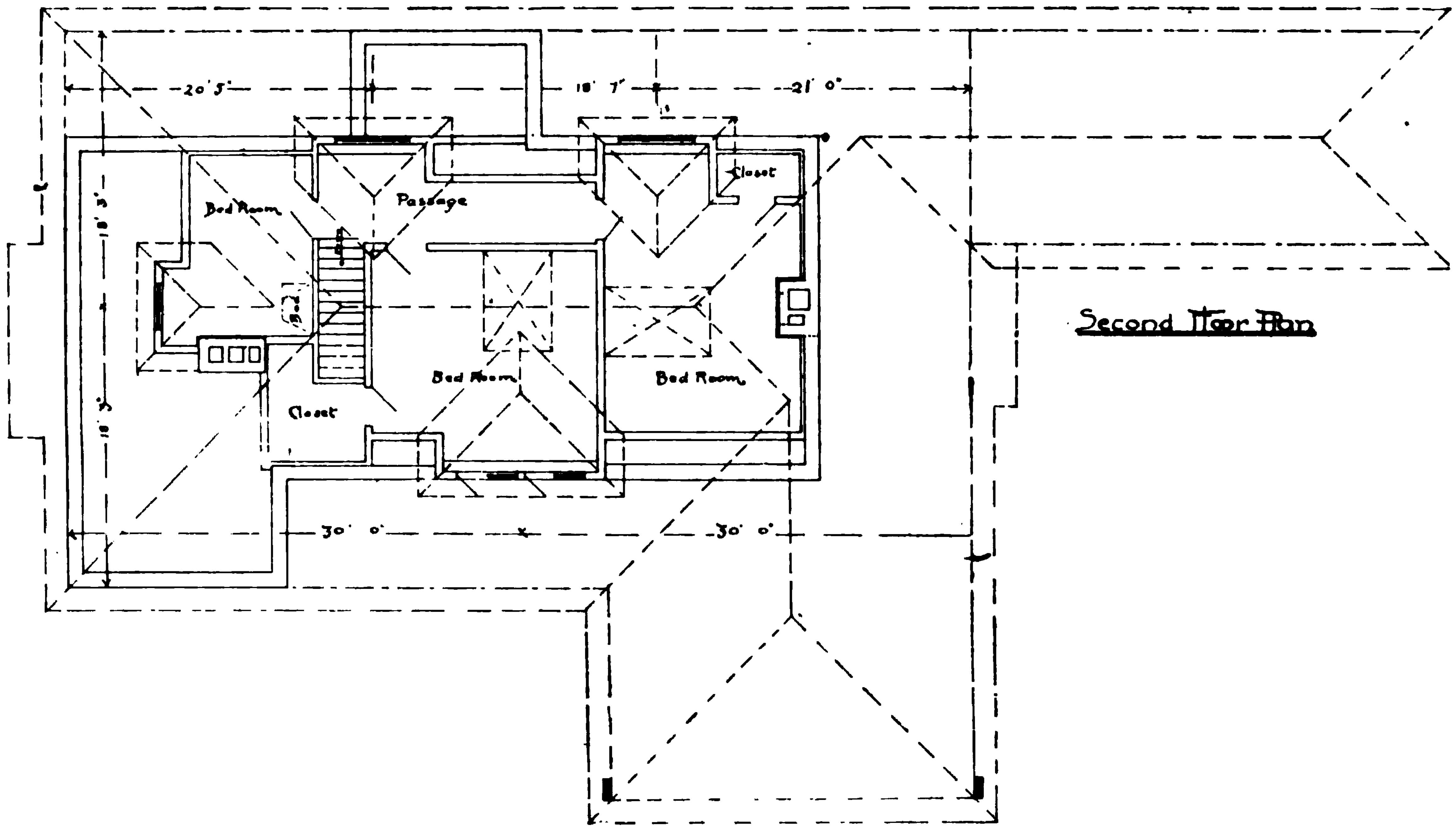


FIG. 63.—Second Floor Plan of Local Passenger Depot at Oakdale, Long Island Railroad. (Plan No. 39, Committee Report on "Local Stations.")

DISCUSSION.

President.—A very able report has been made on this subject. We are now ready for discussion.

Mr. Stannard.—I do not think I can add anything to what has been so well expressed by the committee in their report, which is very complete. There is only one thing which I would mention that might provoke some discussion, and that is as to whether a platform should be constructed of concrete or brick. I think the day is coming when we shall have to use one or the other. I think the day for plank platforms at all important stations is forever gone.

Mr. Bishop.—At all our large stations, we are adopting the use of vitrified brick. I will give you a statement of the cost of a brick platform I laid at Topeka:

2302 sq. ft. of brick, laid on the flat; 4½ brick per sq. ft.; costing	$3.25	per 100 sq. ft.	
Labor and sand	1.62½	"	
	$4.89	"	
Including curbing and grading	8.18	"	
Laying 5759 sq. ft. of brick, on edge, 7.6 brick per sq. ft., cost of brick		per 100 sq. ft.	$5.49
Cost of labor and sand		"	1.75
		"	$7.24
With curbing and grading		"	$10.45
Cost of 347 lineal feet of curbing stone, 8 in. thick, 42 in. deep.			
Cost of stone		11¼ c.	
Cost of cutting stone		14½ c.	
Cost of setting stone		10¼ c.	
Total			36 c.

A brick platform should have about one-fourth of an inch fall in twelve inches for drainage. At our small stations, we are doing away with all wooden platforms that we can, and all extensions we make out of cinders, using two wooden stringers, and rods, making them eight to twelve feet in width.

Mr. Riney.—At our station buildings, we use plank platforms, and we use both sills and joists, sills 8 x 10 and joists 3 x 8 and 3 x 10, pine. Our platforms are built so as to clear the ends of the ties.

Mr. Bates.—We use brick in a great many cases. We set

our curbing at the ends of the cross ties, and the edge of the platform at the height of the top of the rail.

Mr. Cummin.—It seems to me we are losing sight of one part of this report entirely. We are leaving the buildings alone and are keeping right to the platform question. I would like to hear a little discussion and get the sentiment of the members of this association in regard to the buildings themselves, as to the number of waiting-rooms, etc. I noticed in nearly all cases where plans were sent to me for the preparation of this report, that the buildings had from two to three waiting rooms. There were some few that had three rooms, and those that had were in some of the Southern states where there is an extra waiting-room for the colored people. I may be wrong, but it seems to me that in a small village or town, one waiting-room is sufficient. I am an advocate of the single waiting-room at a depot for a small place. When I first became connected with the Long Island road some years ago, it did not make any difference how small a place was, there had to be two waiting rooms, one for the men and one for the women. No matter what time of day or evening you went into the men's waiting-room, you would always find a number of loungers lying around there talking, smoking, etc. The ticket office, as a rule, was placed between the two waiting-rooms. From the ticket office you could hear what was going on in the rooms. I consider this a detriment to any small town or village. We have done away entirely with the double waiting-room. We make one waiting-room do for all, and we allow no lounging around that room, and no smoking in the waiting-room. This plan has worked very successfully. We have sheds at the end of the depot, and if a man wants to smoke he is at perfect liberty to go outside and smoke, but we allow nothing of that kind in the station. In regard to platforms, the majority are plank. We have some concrete platforms, and personally I am highly in favor of them. Our platforms are ten inches above the rail, but in regard to the height of the platform above the rail, it seems to me that the whole question hinges on how high the bottom step of your car is above the rail. I noticed on a number of roads that the cars have extra steps on. Of course that would make a difference, but it seems

to me the height of the platform should be gauged by the steps of the car, so that in walking down from the car the riser from the bottom step to the top of the platform should be equal to the risers of the car. I think you will agree with me, if you are going down a flight of stairs, and there is a riser in those stairs different from the others, the jar will be considerable, and I think that is a thing that should be looked after. The correct rise and height of the platform should be seen to, so that there will be uniformity throughout. Mr. Cummin then cited a case that had come under his own observation, where the track had been raised at a depot platform, causing such a lack of uniformity in the platforms that passengers stumbled, and he was obliged to go to work and re-arrange the platform so as to prevent a continuation of the stumbling referred to.

Mr. Berg.—I would like Mr. Cummin to carry on the discussion of the single waiting-room depots, and explain how the toilet rooms are arranged.

Mr. Cummin.—In all small places the toilet rooms are separate trom the station. In some depots we have toilet rooms. The women's toilet opens from the waiting-room, and the men's from the outside of the building.

Mr. Aaron S. Markley.—Our road at small towns, and at a great many of the larger ones, has only one waiting-room. The height of the platform is four inches above the rail. We use cinders at small stations, thus doing away with the plank altogether for platforms, using old stringers for curb. At larger stations, we put in three inches of crushed stone on top of cinders, and find that this allows the handling of freight with trucks very nicely after once packed. The only objection to that kind of a platform is, in wet weather the material will stick to the shoes, and it is carried into the house. At our small stations, where the ticket office and the waiting-rooms are in one, one stove answers for both rooms, waiting-room and office, by having wire screen in partition opposite stove to prevent it from catching fire, and partition made of slats so that heat will circulate over the two rooms.

Mr. J. H. Travis.—In regard to the construction of waiting-rooms at depots. On all Southern lines, it is necessary to have

at least two; we have got to have a white and a colored waiting-room. I believe it is the same pretty much in all the Southern states, Mississippi particularly. It is somewhat different, of couse, in the case of waiting-rooms on Southern roads, such as the Illinois Central and other roads in the South, than it is on the Long Island road. I think the elevated platform is by far the safest and easiest of access. We have been running express trains since the beginning of the World's Fair, and have not had an accident of any kind. We can load and unload passengers in one sixth of the time that we could in any other way. Our standard for outside station platforms is three inches above the top of the rail. The safest and best platform is that level with the top of the rail, not to exceed three inches anyhow. I would prefer level with the top of the rail. We have not any standard depot, but our depots are constructed very similar to each other. They are built to meet the requirements of those they are intended to accommodate. At quite a number of our stations, including the majority of the whole line between the Ohio and the Mississippi rivers, we have the passenger stations on one side of the track and the freight depot on the other side.

The passenger platform is generally on the opposite side of the track from the general business portion. We have two waiting-rooms at our regular passenger stations; the ticket office is in front with a bay-window, and generally an opening between the two rooms. The ticket and toilet rooms are separated by a partition clear up to the ceiling. The ticket office is in front, and right opposite to that would be the toilet room. I find this is as convenient as any. At our smaller stations north of the Ohio river, there is just one waiting-room. The depots here are a sort of combination, transacting both freight and passenger business, doing away with the necessity of a freight depot on the opposite side of the track. These depot platforms are three inches above the top of the rail, principally constructed of brick and concrete.

Mr. Yereance.—I do not know that I can add much to what has already been said. Our stations are the ones originally built for the line and are of several standard classes, designed to meet the needs of the communities they serve. Our smallest

stations have but one waiting-room; those of the larger classes have two waiting-rooms, but for some reason the separating partition does not reach to the ceiling, and communication between these rooms is had by means of swing doors. In the latter cases, of course, we have to prohibit smoking in the men's room, and if smoking is prohibited, I do not see but one room will answer all purposes. When there are the two rooms, I have found that the privileges of the men's room, especially in small towns, are very apt to be abused by those who have not the slightest claim on the company to consideration. In country places we have the toilet accommodations outside the station building; in larger communities we have the entrance to the men's toilet room outside, but entrance to the women's toilet room from their waiting-room. Concerning station platforms, we are in favor of filling from the level of the bottom of the ties with cinders, up to a height of two or three inches from the top of the rail, and filling up to top of rail with stone-dust dressing. This makes, where it is packed hard, a very desirable substitute for a platform. Of course, in stormy weather, while this material is loose, there will be more or less of it tracked into the station, making the floor dirty and marring its finish.

Mr. Cummin.—We had high platforms on the Long Island road for sixteen years. We tried them in every conceivable way, but were glad to abandon them. On a division of about fourteen miles, the platform accidents amounted to more than the entire system three times over. A high platform will do very well for an elevated road, but it does not answer on a regular road, where you are running local, express, and all classes of trains. I claim from experience that it is the most dangerous platform that has ever been built, especially if you happen to have your station on a curve, which sometimes happens to be the case. This subject was discussed about a year ago in the *Railway Age*, but the subject did not last quite as long as I had hoped it would. It dropped very suddenly. I wrote an article, I believe, at that time, and I was in hopes, as I knew our friend, Mr. Travis, was starting in on the high platform question, that he would go for me, but, though, like a good soldier, I did not fire off the whole of my ammunition,

reserving a little for later use, I did not hear from them after that.

Mr. Travis said, in answer to a question addressed by Mr. Yereance, that when he used the term "express," he meant to make it understood that they had two distinct services into and out of Chicago. They had a local station and an express suburban service. Their local suburban trains stopped at all stations; their express suburbans did not. An express suburban would run from Van Buren St. to Hyde Park without stopping, and the local suburban would stop every three or four blocks. The platforms on the cars of these trains are so constructed that they are about, on either side of the car, eleven inches wider than the car itself from the width of the platform. The platform is five feet, six inches from the centre of the track and is about two feet, four inches high. The distance between the end of the extended portion of the platform of the car and the face of the elevated platform would be about six inches. We do not use the elevated platform throughout, but only in connection with our suburban business. On Chicago Day we carried 758,000 people going to and from the World's Fair, without a single accident. The only accidents we have had with our elevated platform have been due to people running, trying to catch a train, or with smart Alecks getting off before the train stopped. (Mr. Travis then explained in detail the suburban train service of the Illinois Central, how same was run during the World's Fair, the time between the running of trains, the stoppages made, the places where made, the methods employed for the protection of the numerous passengers handled, and concluded as follows:) We adopted every extra precaution we could to insure safety in the way of making repairs and doing work around terminals. I have made an effort to have every employé carefully watch and not leave anything on any of the elevated platforms that might be considered in the nature of an obstruction or cause an accident, and I have gone so far as to say to the employés that if they saw anything that was wrong after their working hours, such as a piece of stick or bolt, or anything of that kind, in any place where there was the least liability of accident, to stop and take it away, and that I would be glad to reward them liberally

for so doing. We left no stone unturned to prevent even the smallest accident from occurring.

Mr. Travis said, in answer to a question addressed by Mr. Yereance, that it was only for their quick service and suburban travel that they had the high platforms.

Mr. Cummin.—I would like to ask Mr. Travis, if those cars that he has referred to, are not open cars where the passengers can unload themselves. The reason I ask that question is this, some of the members here are not used to open cars, and any one having experience knows that with open cars you can unload an entire car in the same time you would unload five people out of an ordinary car.

Mr. Travis replied in the affirmative.

Mr. Berg.—I think this question of high versus low platforms bears about the same relationship to the work of our association as the much discussed question of the best splice bars inthe Roadmasters' association, a number of whose meetings I have attended. It comes up periodically and produces quite a discussion. Mr. Yereance's question, when properly understood by Mr. Travis, brought out this valuable point, namely, that they (the Illinois Central railroad) make a distinction in favor of the high platforms for their suburban trains and low platforms for their regular through trains.

Mr. J. P. Snow forwarded the following written discussion:

The almost universal practice at present on the Boston & Maine Railroad is to make passenger stations with one waiting-room only. This applies to large as well as small stations. This room is generally made to occupy one end of the building,—that looking towards the principal approach to the depot from the village or city. This arrangement is liked much better by every one than the old-fashioned style of separate or semi-detached rooms. In our very largest city stations, smoking rooms are sometimes provided, but they are very seldom occupied. In large stations built several years ago, with a large central general waiting-room, and a side parlor for ladies, and a smoking-room for gentlemen, the people will all be found in the general room; it is the exception to find any one seated in the other rooms. Even at points where emigrants are transferred, the rooms provided for them are not used enough to pay for their maintenance. It is being proposed to provide but one toilet room in rural stations, but none have been so built as yet. It is entirely practical, however, for small depots and will be adopted soon, I think. Most of the passenger cars built recently have but one closet, and they give just as good satisfaction as those with two.

Our heating is done almost universally with hot water, the very best makes only of heaters and radiators being used. A cellar with cement floor is always provided, and the heater and coal bin placed in it. Radiation in the waiting-room for points south of Central New England is provided at the rate of one square foot for 30 cu. ft. of space, and for points farther north the ratio is increased.

The plumbing fixtures are the best procurable, the water-closet apparatus being Huber or Meyer-Sniffen make, with automatic seat flush. The drinking fountains and wash-bowls are of equally durable and expensive styles. This style of work is put into all new stations, large or small, wherever we have a water-supply. At places where there is no water, the closets must, of course, be dry and an air space is arranged similar to the plan shown for Seabrook. [See page 142.]

Our frame depots generally have shingled roofs and are covered on the sides with clapboards on matched spruce boards with paper between. The inside is sheathed on walls and ceiling with narrow beaded sheathing of North Carolina pine, clear white spruce, white-wood or cypress, finished in natural color. The brick and stone depots have slate roofs, and are finished with light buff brick inside or with quartered oak or other hard wood. My personal preference for inside finish on depots of moderate size is a sheathed or paneled wainscot with walls and ceiling above plastered with adamant or other hard-setting plaster; the wainscot to be finished natural color, and the plaster painted with more or less fresco work.

Our new depots are furnished almost invariably with tar concrete platforms having granite curbs 7 by 18 inches. Where the slope of the ground precludes concrete, we use 2-inch plank platforms, the plank running at right angles to the rail and resting on joists generally 3 by 8 inches, or 10 inches, about 3 feet apart. These joists are supported on underlays resting on cedar posts set in the ground. Spruce plank are generally used, but long leaf southern pine is more economical on account of its durability. A medium quality of white pine makes an excellent platform where the wear is not excessive. The practice for some years past has been to put the edge of platform 2 feet, 6 inches from outside of rail, with the top level with top of rail. A rise of about 1-4 inch per foot is given from the front to the back. This requirement brings the timber into the ground so badly that concrete is much preferable to wood for platforms, and hence its use. We specify 4 inches of concrete after it is rolled, to be put down in three layers. It costs about fifty cents per square yard, and the granite curb from 60 to 75 cents per running foot, furnished and set. The concrete, if of proper materials, and if properly put down on good bottom, will stand any amount of hard usage from baggage and trucks.

V.—Tanks, Size, Style, and Details of Construction, Including Frost-proof Protection to Tank and Pipes.

REPORT OF COMMITTEE.

Mr. President, Officers and Members of the Association of Superintendents of Bridges and Buildings:

Your Committee on Tanks, including Frost Proofing, size, style, and construction, beg leave to offer the following:

After considerable correspondence with different members of this association we find that most roads use the standard 16 ft. x 24 ft. tank with a capacity of 50,000 gallons. These tanks are placed on various styles of sub-structures, some of which are oak, others pine; but the most up to date sub-structure is that made of steel, which we find quite a number of roads have adopted or are about to do so.

As for Frost Proofing, some roads box up their pipes with brick-work, others use lumber, which is considerably cheaper and answers the purpose nearly as well. Where it is exceedingly cold during the winter it is good policy to house in the sub-structure and keep a fire under tank, allowing the smoke and heat to pass through a pipe near valve in tank and out through roof of tank. In this case it may be necessary to ceil over the upper joist in order to hold the heat from stove as much as possible.

There is an old saying that "The best is the cheapest," and it will hold good in this case, and your committee desire to offer the following: That a first-class white pine tank, placed at an elevation of 25 feet above rail on a steel sub-structure and stone foundation and connected with a 12-inch pipe to a 10-inch standpipe, is the most economical and modern structure of the kind at the present time.

The transportation department are frequently asked how quick can you get a shipment of goods over your line, and here the question of water supply is one of great importance to them, and by reducing the stops for water from five to six minutes to one or one and a half minutes means hours to some roads in the delivery of shipments requiring quick transportation, and your committee, believing in progression in all matters coming under their charge, have offered you what they believe to be the best and most economical water tank and standpipe at the present date.

We also submit a detailed statement of material and labor to construct a 16 ft. x 24 ft. tank as used by the Chicago & West Michigan Railroad.

3 pieces oak	12 in. by 12 in. by 12 feet,	432 ft. at .18	$7.78
14 pieces white pine	12 in. by 12 in. by 16 feet,	2,688 ft. at .13	34.94
2 pieces white pine	12 in. by 12 in. by 26 feet,	624 ft. at .17	10.61
16 pieces white pine	4 in. by 6 in. by 20 feet, S 4 S,	640 ft. at .13	8.32
23 pieces white pine	4 in. by 6 in. by 16 feet, S. 4 S,	736 ft. at .12	8.83
10 pieces white pine	3 in. by 12 in. by 26 feet, S 4 S,	780 ft. at .17	13.26
2 pieces white pine	3 in. by 12 in. by 24 feet, S 4 S,	144 ft. at .16	2.30
2 pieces white pine	3 in. by 12 in. by 20 feet, S 4 S,	120 ft. at .14	1.68
2 pieces white pine	3 in. by 12 in. by 16 feet, S 4 S,	96 ft. at .13	1.25
2 pieces white pine	3 in. by 12 in. by 14 feet, S 4 S,	84 ft. at .13	1.09
6 pieces white pine	2 in. by 2 in. by 16 feet, S 4 S,	32 ft. at .12	.38
8 pieces white pine	2 in. by 12 in. by 12 feet, S 1 S,	192 ft. at 12.75	2.45
16 pieces white pine	1 in. by 8 in. by 12 feet, S 2 S select,	128 ft. at .30	3.84
10 pieces white pine	1 in. by 12 in. by 16 feet, S 2 S select,	160 ft. at .30	4.80

4 pieces white pine 1 in. by 10 in. by 16 feet, S 2 S select,	53 ft. at	.30	$1.59
50 pieces white pine 2 in. by 6 in. by 14 feet,	700 ft. at	11.75	8.23
1 piece white pine 8 in. by 12 in. by 12 feet,	64 ft. at	.11	.70
8 pieces white pine 2 in. by 4 in. by 20 feet, S 2 S,	107 ft. at	12.75	1.36
8 pieces white pine 2 in. by 4 in. by 16 feet, S 2 S,	83 ft. at	.11	.91
16 pieces white pine 2 in. by 4 in. by 14 feet, S 2 S,	149 ft. at	.11	1.64
275 pieces white pine 1 in. by 6 in. by 16 feet, ceiling,	2,200 ft. at	.17	37.40
4 pieces white pine 2 in. by 4 in. by 18 feet, S 4 S,	48 ft. at	12.50	.60
8 pieces white pine 1 in. by 6 in. by 12 feet, S 2 S, select	48 ft. at	.29	1.39
6 pieces white pine 1 in. by 6 in. by 16 feet,	48 ft. at	.20	.96
5 M. shingles,		2.00	10.00
16x24 ft. tub and hoops,			325.00
12 cap castings,			14.40
12 rods ¾ in. by 21 ft. 8 in. long, 12 rods ¾ in. by 8 ft. 3 in. long,			9.10
150 lbs. 10 d nails,			4.50
100 lbs. 20d nails,			3.00
24 lbs. 4d nails,			.84
48 ¾ in. cast washers,			.48
250 yds. building paper,			15.00
12 gals. mineral paint,			12.00
12 gals. boiled oil,			7.80
Labor, painting,			25.50
Labor, erecting tank,			161.37
Stone foundation,			228.50
Total,			$973.80

We also submit cost to erect tank as used by Chicago, Rock Island & Pacific Railroad.

16 x 24 ft. tank with 12 hoops, 3 lugs each,	$275.00
1 indicator,	5.00
1 set 7 in. fixtures,	68.00
12 iron post caps,	24.00
Rail joist, at $5 per ton,	18.45
Sub-structure, frost proofing, etc.,	198.36
Paint,	14.51
Foundation stone,	68.75
Labor in foundation,	116.00
Labor, painting,	24.24
Labor, erecting tank,	164.72
Total,	$977.03

Mr. T. J. Kinder, superintendent B. & B., L. E. & W. R. R., sends the following cost to erect a 16 x 24 ft. tank and steel sub-structure built by the King Bridge Co. of Cleveland, Ohio. This tank has a 30 ft. elevation, built at Lima, Ohio, and cost $1,600.

We are indebted to Mr. Kinder for the above, as he is not a member of our association. We are also indebted to Mr. W. E. Harwig, master carpenter of the Lehigh Valley Railroad, for blue prints furnished, also detailed list of material and labor to erect one of their standard 20 ft. tanks, as follows:

4,560 ft. 3 in. cypress for staves and bottom, at		$28.00	$127.68
700 ft. 1 in. by 3 in. yellow pine plank for false bottom		20.00	28.00
32 pieces 2 in. by 12 in. by 16 ft. white pine plank,		30.00	30.72
12 pieces 2 in. by 6 in. by 16 ft. white pine plank,		30.00	3.86
50 pieces 3 in. by 4 in. by 16 ft. hemlock scantling,		10.00	8.00
500 ft. 1 in. hemlock boards,		10.00	5.00
700 pieces white pine car siding,		25.00	70.00
200 lineal ft. beveled siding,		25.00	2.50
8 pieces 1 in. by 6 in. by 16 ft. white pine (facia boards),			
8 pieces 4½ in. O. G. battons,			
4 pieces 1 in. by 3 in. by 16 ft. white pine (corner boards),			
4 pieces 1 in. by 4 in. by 16 ft. white pine (corner boards), 100 ft.		25.00	2.50
1 door 2 ft. by 10 in. by 6 ft. 10 in.			3.00
1 door frame for door 2 ft. 10 in. by 6 ft. 10 in.,			2.50
4 pieces 1 in. by 8 in. by 16 ft. white pine, for base,		30.00	1.29
1 piece 10 in. by 10 in. by 7 ft. white pine, for spire,		30.00	1.74
1 ladder,			3.00
1 16 ft. ladder, white pine			3.00
2 pieces 4 in. by 7 in. by 26 ft. white pine,	632 ft.	30.00	18.96
9 pieces 2 in. by 7 in. by 16 ft. white pine,			
2 pieces 4 in. by 7 in. by 17 ft. white pine,			
6 pieces 4 in. by 6 in. by 22 ft. white pine,			
1 tell-tale,			3.00
1 hank sash cord,			.75
¼ in. side pulley,			.05
2 kegs 8d wire nails,		.0178	3.56
1 keg 10d wire nails,		.167	1.67
1 keg 20d wire nails,		.0153	1.53
5 lbs. 8d wrought nails,		.025	.13
1-6 lever padlock,			.38
2 pairs 8 in. strap hinges,			.35
1 8-in. hasp,			.50
1 rod ⅞ in. by 7 ft. 10 in., with nuts and cast washers,			1.50
56 cubic yards masonry,		$5.00	280.00
2,720 lbs. wrought iron (hoops),		.03	81.60
Lead, etc.,			35.00
Labor,			175.00
Total,			$896.77

We also submit you quite a number of blue prints from different roads; also blue prints from the King Bridge Co. of Cleveland, Ohio, and the United States Wind Engine & Pump Co. of Batavia, Ill., which we think will be of interest to all members of the association.

We are respectfully yours,

W. O. EGGLESTON,
W. M. NOON,
A. MCNAB,
N. W. THOMPSON,
Committee.

NOTE. I do not concur in the statement that a 12 inch pipe and 10 inch standpipe is necessary. With a 22 feet elevation, 8 inch pipe and 8 inch standpipes, our engines can fill a tank in 1½ to 2 minutes (3,600 gallons) if tub stands within 200 or 300 feet of standpipe.

N. W. THOMPSON.

DISCUSSION.

President.—The principal points to bring out are the kind of lumber used in the tub, and the kind of material in the substructure, whether of wood or iron or steel, and the methods of frost proofing. I think these are the main features.

Mr. Nutting.—In 1886 we bought six tanks 12x18 of Michigan pine and set them up directly. They have been in use ever since. The bottom half of the staves in tanks began to give out some time ago; on examining them, I found that the inside of the stave was entirely rotten, and that you could stick your finger through nine out of ten of them without any trouble. In 1890 we put up twelve more of these tanks, of the same kind of timber as the first lot, and they are going the same way as the others. Three years ago I had made at my headquarters some long leaf pine tanks. They have not been in use long enough yet for a true test. So far, they are giving very good satisfaction, and are, I think, better for the southern climate than tanks made of white pine. White pine will shrink and swell more than yellow or long leaf pine, in the hot sun of the South. The sun striking the staves on both sides during the day, will shrink a white pine stave, "when the water gets low in the tank," from one eighth to a quarter of an inch. With the long leaf pine we have not had this trouble. They have been in use three years or more; the hoops are tight; have never had to send men to attend to them, and they have stood remarkably well. For tank foundations we use both stone and wood. Masonry costs us three dollars per cubic yard.

The long leaf pine tanks cost us, ready to set up, less hoops,	$75.00
4575 feet of timber in substructure, cost,	32.02
For labor putting up tank complete,	97.75
Total for tank put up on wood foundation,	$204.77

Mr. Garvey.—Three years ago I began putting up tanks on our road, beginning at the foundation. At first, I just dug a drain three feet wide and four feet deep, twenty-four feet for centres, and fourteen feet for outside, and we filled in with broken rock and gravel, and put rock on top, laying sills on

that. In our climate the frost is very deep, and we changed the plan of using stone to driving piles. We drove twenty-two piles in foundation for a tank and sawed off about a foot above the ground and put on the frame. We use white oak and white pine 12x12, and we use 6x12 for sills, for joists under the top, and on the four centre posts of the tank. We boarded them up inside and outside, and filled up between with sawdust. We put a door on and put a valve under the tank. We put a coat of coal-tar on the tank to prevent staves from rotting. I get a report every morning as to each tank. The agents are supposed to report the condition of the tanks every morning, and when these reports come in I see them, and if there is not as much water in any of them as there should be, I find out right away what the trouble is. These tanks have not been up long enough to warrant a definite opinion being given. There are other tanks on the road that were there before I came to it, but we are replacing these as fast as we can. We are having very good satisfaction with pine tanks so far. We put a shingled roof on the tank. Formerly we used to box the whole frame under the tank, but we lost two tanks by fire on account of tramps breaking in and building fires, and since then we have taken down all the sheet-iron and boxed up the pipe.

Mr. J. L. Neff.—I have had a little experience with water-tanks in a great many different ways. The first tanks I put up I had a great deal of trouble with; afterwards, I started in to suit myself. I did away with all sawdust, and I started in with eight thicknesses of boards. I took up my valves. The valve that was in the top I did away with. Since I have come back on the road, I have found that all the timbers have become rotted, and they have had to be renewed. I made a large box, taking in the four centre posts, and filled in with sawdust. I had occasion to take down a tank at Maringo, Ill. It was made of two-inch staves. The agent told me that he had been attending to the water works twenty-four years and that that tank was up when he came on the road. This tub was made of the best material. After it was taken down, the man was asked what he was going to do with the lumber, and we understand he made framing for his house of it. This tank was probably from

twenty-five to twenty-eight years old. I do not think heavy staves in a tub are a benefit.

Mr. Garvey.—I understand that if sawdust gets wet where it is packed in, it will certainly rot the timber; but as long as it can be kept dry, it will not rot the timber. We sometimes take off a board to see that it is all right. We are far up North. There are some places on our road where it is twenty-five degrees below zero sometimes, and you have to protect yourself.

Mr. Foreman.—We have both kinds of tanks, round and square. The square tanks are made of four-inch pine and hold 60,000 gallons. The square tanks were made in 1864 and are there yet. The round tanks are two inches, and have been there ten years. We put a roof on. My opinion is that the square tank is the cheaper. It costs from $700 to $800. We put bolts in them. As to the heating of them, we of course do not heat them all together. We have a stone foundation. In some cases we have got down to five feet; in other places, three. Have never experienced any trouble during the winter time.

Mr. J. H. Markley.—I would like to ask if the foundations are not housed in.

Mr. Foreman.—No, sir.

Mr. Large.—I have had quite a long experience with water-tanks, thirty-five years, off and on. With round and square, large and small tanks; and I find that a round tank without a house around it, or, as we call it, a frost-proof tank, without any packing underneath it, and a vault built around the pipes not connected with it, of two thicknesses of boards set eight inches apart and filled with sawdust, has given the best satisfaction of any that I have had to do with. I have built them with no protection except the roof, where we got seventeen years' service out of them, and then they did not rot so much from outside exposure as from allowing an accumulation of sediment in the bottom of the tank. The L. S. & M. S. Ry. have recently taken down a tank that was put up in 1872, that was built in that way. The material in it was fairly good. If they were hard up, it would have lasted three or four more years; but they wanted a larger tank.

In answer to N. H. Markley, Mr. Large said: We used white pine all through the tank referred to as being put up in 1872. It was taken down within a month.

In answer to Mr. Nutting, Mr. Large said, in regard to the effect of paint on the outside of tanks: I have never put one up and allowed it to stand for any length of time without painting. I recollect that I put one up, a good many years ago, on the P., F. W. & C. Ry., and we painted it inside with coal-tar. The lumber was not properly seasoned, and we were delayed about getting the water turned into it; and when we got it turned in, the tank had shrunk so that it would not hold water. We took the hoops off and put in one more stave, and did not paint it. After several years, we took the tank down, and the stave that was not painted was from three-eighths to one-half inch thinner than the balance of the staves, although they were originally all one thickness.

Mr. Thompson.—My experience is the same as Mr. Large's. We work on the same division, and build the same kind of tubs. I always use sawdust. I put up four posts so as to close all the pipes, receiving and discharging, leaving about eight inches for air-space. Never had any trouble with pipes freezing. There are no valves in the pipes. Those up seventeen years are in fair condition. They have not yet rotted or fallen down. Whether it would be a good idea to build a steel tank, I do not know. We pay from $325 to $350 for a wooden tank ready to set up. The steel tank costs $533. A question in connection with the steel tank is, whether we could keep them from leaking. Would like to have the members study up this question, and give their views at some future time.

Mr. Bates.—I have known some tanks to fall down through the rusting of the hoops from the inside, caused, as I believe, by using alkali water from artesian wells. I have samples of such hoops in my office, and if I had known they would have been of interest, I would have brought them to this meeting. In the inspection of tanks we have to be careful to try the hoops to see that they are not eaten up from the inside.

Mr. McIntyre.—Would this not be due to lack of paint?

Mr. Bates.—Very likely. I think hoops should be painted

on the inside and the tank staves on the outside, before the tanks are erected. They would then hold water better, and last indefinitely.

Mr. Markley.—We have tanks that were put up in 1881, and they are still in a good state of preservation. Have had no trouble with them.

Mr. Cummin.—The tanks on our road are all enclosed from the foundation up. We use cedar tanks altogether, frame 12 x 12, yellow pine. The entire foundation is closed in. On the ground floor we usually lay a two-inch floor. The outside of the frame is sheathed with one-inch pine, then clapboarded on the outside. We have no trouble with the pipes whatever, from freezing or otherwise. We have some tanks put in in 1884, and they are in first-class condition yet.

Mr. A. S. Markley.—Last summer we took down two tanks that were put up in 1878, of white pine. They were not as bad as they might have been, and would have lasted at least another year. We have tanks up now since 1880, and they will probably last two or three years longer. We put up tubs in 1886, and, as far as I can judge, they are good for twenty-five or thirty years.

Mr. A. McNab.—It is natural for members to think that we should have more trouble with our water-tanks on the north end of our road than we do on the south end, but my experience has been that we have had more trouble with our tanks freezing in Indiana, than we have had on the north end, and our tanks are all frost proofed just the same; every tank we have is frost proof. I sometimes think there is a good deal in the water; on the north end of our road we use all spring water, and we know it will not freeze as readily as the surface water. We use a 16 x 24 foot tub. On the north end we have several tanks with wood foundations, but on the south end they are all stone. We use twelve posts under our tanks, with iron caps on top of post. For our frost proofing we have three thicknesses of seven-eighths ceiling and three thicknesses of paper, taking in the four centre posts; our feed-pipe and discharge pipe come directly under the centre of tub; we build a box around them entirely separate from the outside frost proofing; we use about eight inches of

sawdust in this box. Of course, we have double doors, and they are also filled with sawdust; and we have a valve in the discharge and feed-pipes under the tank, so that if anything occurs at the stand-pipe, we can shut the water off any time; we do the same thing, practically, where we use the double floor. About every two years, I have a man go over the road, and have the sawdust boxes filled up, as the sawdust settles more or less, and requires refilling. I do not think we have had a tank freeze up in four years; they are pretty well looked after.

A Member.—Have you the cost of foundation for a water-tank?

Mr. McNab.—The cost is $125.

President.—Water-tanks that are built for the Duluth & Iron Range R. R. are usually made of cypress, three-inch staves, 16 x 24, built on stone foundations, with wooden posts. We build our tanks on the extreme edge of the right of way, and use stand-pipes. We do not put any of our water-pipes in the ground. When I first took charge of the Bridge and Building department on that road, all the water-pipes were buried in the ground about six feet. All the tanks were frost proofed by filling the parts with sawdust. I spent two years tearing out what sawdust there was and taking up all the pipes. I did that, attempting to repair them on the same lines as they were built, but since that we have taken them out entirely and put them in wooden boxes. The boxes are very much as Mr. McNab has described. We build a small box around the pipe, cover this with tarred felt, then put on an inch strip about every four feet, encircling these boxes, then repeat this until we have three dead-air spaces. We find that the dead-air space is the secret of the prevention of frost from reaching the pipes. Since we have adopted this method of construction, we have never had any trouble, and are perfectly satisfied with the arrangement. This practice is all right for a temperature of 40° to 60° Fahrenheit. I might add that we usually excavate our tank foundations in the form of a Greek cross, then put a layer of concrete eighteen inches thick over the whole surface, then build the piers. We are very particular to provide for sub-drainage from the lowest portion of the foundation, wherever it is possible to secure it.

Mr. Thompson.—In our tank foundations the lowest course is six feet square, the next course five feet square, and the next four feet; then we have a cap-stone set there that is beveled in some places. Our standard foundation is of stone.

Mr. Markley.—We are just putting in a foundation now, and we do not use foundation piers to exceed three feet square. We use good cement, but we do not exceed a yard or a yard and a half. All you have to look for is a good foundation.

Mr. McNab (addressing President).—Do I understand that your discharge pipe is above ground?

President.—Yes. We put up light trestle bents about eight feet apart, and on this we place the frost-proof box in which the discharge pipe is carried. I will add, that in addition to the construction I have described, we take a three-quarter inch iron pipe and run it from the boiler to the tank and returning through this box, so that in extreme weather we can heat the boxes, if necessary. We very seldom find that necessary.

Mr. McNab.—Do you use stand-pipes?

President.—Yes. We carry the supply pipe from tank to stand-pipe in the same kind of frost-proof box as described heretofore, drop the box under the track and fill over it with cinders.

Mr. Riney.—I present a detailed statement, showing the cost of four of our tanks. The tanks are 16 x 24, on 24-ft. posts:

SPARTA, WISCONSIN.

Labor.		*Material.*	
Building tank,	$263.00	Water-tank,	$275.23
Painting tank, two coats,	26.25	2 8-in. Mansfield stand-pipe,	380.00
Laying pipe and setting stand-pipes,	178.20	540 ft. 8-in. pipe and fittings, valves, etc.,	315.10
Building masonry,	209.00	1 bbl. pitch, 1 bbl. oakum,	6.40
		Posts, caps, and braces for tank,	209.41
		Stone for foundation and two stand-pipes,	309.00
		108 ft. 4-in gas-pipe,	21.60

EVANSVILLE, WISCONSIN.

Labor.		*Material.*	
Building tank,	$200.57	Tank complete, including posts, braces, and caps,	$304.33
Laying pipe,	198.86	One 8-in stand-pipe,	190.00
Painting, 3 coats,	34.50	Two 8-in. gate valves,	45.00
Digging well, 16 x 18, and walling up same,	290.00	608 lbs. lead,	21.28

Foundation for pump-house, and stand-pipe,	$120.00	660 ft. 8-in. cast-iron pipe,	$254.55
		Lumber for well, pump-house, and stand-pipe foundation,	23.09
		80 ft. 4-in. gas-pipe,	16.00
		Paint,	19.53
		Stone, cement, etc.,	288.50

ELROY, WISCONSIN.

Labor.		*Material.*	
Building,	$238.35	Tank,	$275.23
Laying pipe,	93.17	One 10-in. stand-pipe,	225.00
Painting, 2 coats,	31.00	90 ft. 10-in. cast-iron pipe,	71.66
Tank, and stand-pipe found.	132.56	Fittings for pipe and stand-pipe,	65.34
		Foundation for tank and stand-pipe,	150.00
		Paint,	13.02

MONONA YARD.

Labor.		*Material.*	
Building,	$228.35	Water-tank,	$304.23
Laying 3,000 ft. of pipe, 20c. foot,	600.00	10-in. stand-pipe,	225.00
Painting, 2 coats,	29.00	60 ft. 12-in. cast-iron pipe,	71.66
Foundation stand-pipe,	18.00	Valves, elbows, and fittings,	65.34
Foundation tank,	111.56	2,586 lbs. lead, 3$\frac{3}{8}$c. per lb.,	87.28
		250 pieces 6-in. cast-iron pipe,	1,229.90
		Paint,	19.53
		Material for stand-pipe,	21.00
		Material for tank,	129.00

Mr. Riney.—All our standard tanks are put up on posts, and from them we use the stand-pipes. The eight outside posts are vertical posts and all left open. We have had no trouble with frost. The old tanks were all boxed in. We used stoves, but these are being done away with as fast as we remove the tank. We are now using a 12-inch pipe from the tank.

Mr. Thompson.—What is the distance from the stand-pipe to the tub?

Mr. Riney.—From 700 to 2,000 feet.

Mr. McNab.—I would like to ask if these figures include foundations or erection of tank, stand-pipe, and laying the pipe.

Mr. Riney.—The figures given are for the entire work complete, as shown in the itemized statement.

Mr. J. P. Snow forwarded the following written discussion:

The custom on some lines of using timber sills under the posts of the ordinary tank appears to me to be bad practice. It is well known that timber in a horizontal position is not as durable as when vertical; moreover the sills are laid directly on the masonry and absorb moisture from it, and all spray from the spout (when used), and all leakage is quite likely to keep them wet on top. The load on the feet of posts as ordinarily framed in a 50,000-gallon tank is nearly 300 lbs. per square inch. This, with the softening due to the sources of decay mentioned above, causes the sills to crush very early. The caps, although the same size as the sills, last as long as the posts.

The practice of using cast-iron bases for the posts is much better, but I agree with the committee that a steel or iron substructure is to be preferred to timber posts. I would favor posts made of two angle irons riveted Z fashion, furnished with a generous sized riveted top to receive the cap timbers and to be well braced with angle iron bracing.

I estimate this to cost for a substructure twenty feet high, $125 or $130 more than timber posts and sills.

VI. Best and Uniform System of Report Blanks for Bridge and Building Department.

REPORT OF COMMITTEE.

To the Association of Railway Superintendents of Bridges and Buildings:

Your committee appointed to investigate the best and most uniform system of report blanks for bridge and building departments, desire to submit the following report:

We have received from a number of roads copies of forms used by them, and find that with the exception of time books, there is a great diversity of forms and methods of reporting.

In many cases the forms are for general use of the various departments of the system, and seem to be prepared to suit the general accounts, and also indicate that the statements required of expenditures on bridges and buildings differ in almost every instance. Therefore, on account of the various conditions under which bridge and building department work is performed on the different systems, and by reason of the fact that in many cases the forms are adapted to general use, and that any change might affect the general accounts, we have deemed it best to recommend only the following forms, and have arranged and classified all the other forms submitted so that they may be examined by the members and notes taken of such as are suited to their respective roads.

FORMS RECOMMENDED.

Time Book: As per marked sample, to be 4½ inches x 7 inches, and the number of leaves to be varied in accordance with the size of the crew, covers to be oil boards with cloth back. This book is recommended because it shows the over-time. It is intended that it shall be in use one month only, and retained in the office of the person making the distribution of time.

For reporting material used, Mechanics Diary, U. P. System, with alterations shown in pencil on first leaf. The number of pages in the book to be determined by the road using it.

Bridge and Building Record Account Book: None of the roads submitted sample of their record books, with the exception of the C., M. & St. P. R'y, which submitted forms for cost of bridges and buildings. Their system is to record in an ordinary journal-ruled book the charges to the work as they appear in the monthly distributions of labor and material, and when the structure is completed the cost is analyzed as indicated by the forms submitted.

In our opinion the above forms are the best, and can be adopted by any of the roads submitting forms without any serious alteration in their methods of reporting.

Geo. J. Bishop,
W. O. Eggleston,
Onward Bates,
M. Riney,
Committee.

Chicago, March 23, 1896.

Form blank.

TIME BOOK for the Month of..189 .

NAME.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total time.	Rate per day.	Amount.	
																																		$	Cts.
{ Regular Time, { Over Time, TOTAL TIME, DISTRIBUTION.																																			

To complete form, horizontal lines should be added.

Account of Material Used on Each Job.

During the Month of .... 189 . *By* .... *Foreman.*

No. of job.	Location, name and description of job.	No. of articles.	Description.	Dimensions.	Quality.	Price.	Amount.

To complete form, horizontal lines should be added.

Buildings.

C., M. & St. P. Ry. Co.—Bridge and Building Department.

Statement of Cost.

.... at ....

Building Dimensions...

Description...

....

....

Platform Dimensions...

Description...

....

Built during months of... 189

Foundation—				
Labor, Excavating..............................	....	....	....	....
Masons..............................	....	....	....	....
Carpenters..............................	....	....	....	....
Cwt. Stone..............................	....	....	....	....
M. Brick..............................	....	....	....	....
Sacks Cement..............................	....	....	....	....
Sand..............................	....	....	....	....
Posts, &c..............................	....	....	....	....
....	....	....	....	....
Building Proper—				
Labor, Carpenters..............................	....	....	....	....
Masons..............................	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
Chimney—				
Labor, Masons..............................	....	....	....	....
....	....	....	....	....
....	....	....	....	....
Platform—				
Labor, Carpenters..............................	....	....	....	....
Ft. b. m. Lumber and Timber..............................	....	....	....	....
....	....	....	....	....
....	....	....	....	....
Engineering..............................	....	....	....	...
Total Cost of Building and Platform..............................	....	....	....	....

Analysis of Cost.

Building and Foundation per sq. ft. of floor surface..............................

Building and Foundation per cu. ft. of contents above foundation..............

Building, exc. of Foundation per sq. ft. of floor surface..........................

Building, exc. of Foundation, per cu. ft. of contents above foundation..........

Chimney per thousand of brick used..............................

Plastering, per sq. yard of surface, ex. of openings..............................

Platform, per sq. foot of surface covered..............................

Platform, per thousand feet b. m. of lumber and timber used....................

Building exc. of F'd't'n per thousand feet b. m. of lumber and timber used... .

Iron Bridges.

C., M. & St. P. Ry. Co.—Bridge and Building Department.

Statement of Cost.

.... Bridge No. .... over .... Division ....

....

....

Built during months of.................. 189

Volume of Masonry:

Bridge Stone..... ......Cu. Yds.	....	Ass't Eng'r.....................	
Block Rubble........... " "	....	Masonry Foreman.............	
Common Rubble......... " "	....	Foundation Foreman..........	
Concrete................ " "	....	Iron Bridge Foreman..........	
Total Masonry.......... " "	....		

Foundation—				
Labor...	....	....	....	....
Lin. ft. Piles..................................	....	....	....	....
Ft. b. m. Sheet Piling.......................	....	....	....	....
Ft. b. m. Grillage Timber..................	....	....	....	....
Lbs. Ironwork................................	....	....	....	....
Masonry—				
Labor, Masons and Helpers................	....	....	....	....
Cwt. Stone.....................................	....	....	....	....
Sacks Cement.................................	....	....	....	....
Cars Sand......................................	....	....	....	....
Ironwork—				
Labor, Iron Bridge Crew, Erecting........	....	....	....	....
Lbs. Ironwork................................	....	....	....	....
Labor, Painting..............................	....	....	....	....
Gal. Paint.....................................	....	....	....	....
Floor—				
Labor, Carpenters............................	....	....	....	....
Ft. b. m. Timber.............................	....	....	....	....
Lbs. Ironwork................................	....	....	....	....
Train Service................................	....	....	....	....
Engineering.................................	....	....	....	....
Total Cost of Bridge.......................	....	....	....	....

Analysis of Cost.

Masonry exc. of Foundation, Labor and Material per Cu. Yd. of Masonry.......

Masonry exc. of Foundation, Labor only, per Cu. Yd. of Masonry...............

Masonry and Foundation, Labor and Material, per Cu. Yd. of Masonry..........

Ironwork, Labor erecting and painting, per lb. of Ironwork......................

Ironwork, Labor and Material, per lb. of Ironwork................................

Ironwork, Labor and Material, painting only, per Lin. ft. of Bridge..............

Floor, Labor and Material per Lin. ft. of Bridge.................................

Floor, Labor only, per Lin. ft. of Bridge..

Stone Arches, Rail-Top, and Stone Box Culverts.

C., M. & St. P. Ry. Co.—Bridge and Building Department.

Statement of Cost.

.... No. .... over .... Division ....

....

....

Built during months of.. 189

Volume of Masonry:	
Bridge Stone......................	
Block Rubble................................	Ass't Engineer...... ....
Common Rubble............................	Masonry Foreman..............
Concrete....................................	Foundation Foreman...........
Paving......................................	
Total Masonry.............................	

Foundation—				
Labor..............................	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
Masonry—				
Labor, Mason Crew..............................	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
Concrete—				
Labor, Mason Crew..............................	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
Covering—				
Labor......	....	....	....	....
....	....	....	....	....
....	....	....	....	....
Paving—				
Labor..	....	....	... .	....
....	....	....	....	....
Train Service....................................	....	....	....	....
Engineering......................................	....	....	....	....
Total Cost...	....	....	....	....

Analysis of Cost.

Masonry, Material and Labor per cu. yd. of Masonry...............................

Masonry, Labor only, per cu. yd. of Masonry................................. ....

Masonry and Foundation, Material and Labor per cu. yd. of Masonry...........

Concrete, Material and Labor per cu. yd. of Concrete.............................

Concrete, Labor only, per cu. yd. of Concrete.......................................

Covering, Material and Labor per Lin. ft. of structure.............................

Paving, Material and Labor per sq. yd. of paving..................................

DISCUSSION.

Mr. J. P. Snow forwarded the following written discussion.

I hope the members will consider the scope of the committee as covering regular inspection reports, as well as reports of expenditures alone.

Of course, inspection reports must vary according to the organization and size of the road. Where the head of the department can inspect all bridges himself, he needs only his personal notes, which can best be kept, I think, in a pocket note-book constantly carried. He should have a new book each year, with all the bridges entered conspicuously in consecutive order, giving from a few lines to a couple of pages to each bridge, according to its probable need of attention. Where the system covers several divisions, each with its independent supervisor or general foreman, it would seem that periodical reports of the condition of the structures should be rendered to the central office; even if the office is indifferent to the exact condition of affairs in detail, reports must be rendered to the interstate and state commissioners, and in order to do this intelligently the management must keep in touch with the work more than can be done through the ordinary time returns.

I am not a believer in the necessity of very frequent inspection of bridges that are in good order. As a prominent ~~engineer~~ said, "A bridge that needs going over with a microscope every month, needs rebuilding."

I think the section men should be trained to report anything apparently wrong, which they will do very faithfully if encouraged to do so. For bridges in first-class shape, a yearly inspection by a competent bridge man should be sufficient. Others of more questionable condition should be examined once in three months, and others still that need watching should be looked over once a month or oftener. The reports of these inspections to the chief engineer, superintendent, or whatever official keeps the records, should give the physical condition of all parts, changes made in the structure, if any, since the last report, and recommendations for repairs or renewals. I think these should be signed by the general foreman or supervisor, and that he should keep a copy or abstract, so that he may know each time what he reported previously. These reports are best filled out on the ground, while the inspector is on or under the bridge. I particularly object to a report filled out from notes, or, worse still, from memory, after the inspector has reached a convenient place for filling out the sheet. The supervisor may well delegate some trusty man to examine and fill out the blanks for all bridges in fairly good shape, but he should sign them, so as to insure his being cognizant of the statements made, and he should also fill out the blank for recommendations. The questionable bridges on which he would not care to sign a statement made by a subordinate, he had much better examine himself, anyway. These reports would keep the central office informed, not only as to the condition of the bridges, but also as to all changes made by renewals or repairs.

The blank contained in the abstract of the committee's report does not completely fill the bill, it seems to me. The dimensions, etc., covered by the first five items ought to be permanently on record, and need not be repeated at each inspection. The space for noting the condition of each item seems small and poorly arranged, and the size of sheet makes it inconvenient to carry in the field.

I submit a form that I had printed some years ago, which seems to me to be more intelligent and convenient, although perhaps not covering so much ground as it ought to. Owing to a change of organization, these blanks are not now in use.

Bridge No. ....

189

Points reported poor.

....

....

Recommendations.

PERFORATED.

Bridge No. *189*

Masonry or Piles, ...	*Bearings,* ....
Timber, ...	*Ties,* ....
Bottom chord pulled, ...	*Roof,* ....
Rivets, ...	*Paint,* ....
Line, ...	*Camber,* ....

Miscellaneous defects, ...

....

Recommendations, ...

....

....*Supervisor B. & B.*

These sheets are four inches wide by ten inches long; they are made up into books with pasteboard covers to protect them when in the pocket, and the stub is retained by the supervisor for his record of what he has heretofore reported. On the lining of the front cover, the following directions are printed. The signature serves to define the division from which the report is made.

INSTRUCTIONS TO INSPECTORS.

Blanks must always be filled out at the bridge site by the inspector. The recommendations should be filled out and signed by the supervisor.

NOTE ON ALL BRIDGES.

Masonry or piles: good, fair, or poor.
Bearings: good, poor, clean, or dirty.
Ties: good, fair, or poor.

NOTE ON WOODEN BRIDGES.

Timber: sound or decayed, good, fair, or poor.
Bottom chord pulled: 1-8, 3-16, 1-4, etc.
Roof: good or poor.
Line: good, or out-inches east or west.
Camber: inches up or straight, or inches down.

NOTE ON IRON BRIDGES.

Rivets: number loose.
Paint: good, fair, or poor.
Defects not classified above must be given as miscellaneous.
If repair or renewal is thought to be needed, state it under recommendations.

It is often puzzling to ascertain how it is intended that blanks for any purpose should be filled out. For instance, I should be at loss how to fill the vertical columns of the blank presented by the committee, and if not filled out according to intention, and if not understood alike by all inspectors, the resulting record will be of little value. It was thought that the above instructions would explain what was wanted, so that the blanks would be filled properiy.

VII. The Mechanical Action and Resultant Effects of Motive Power at High Speeds on Bridges.

REPORT OF COMMITTEE.

Mr. President:

The subject which your committee has been called upon to investigate is one which has been before the engineering profession for years, but up to the present time no one has been able to definitely formulate any positive law of action, or even to indicate in an approximate manner just what injurious effects quickly-moving loads have upon bridges.

We all know that trains rushing over a bridge will cause shocks, tremors, and vibrations. We can feel these effects by standing on the

structure, and we realize that the heavier structure is less shaken than the lighter. But if called upon to state in accurate terms the amount of increased strain due to those moving loads, your committee must plead ignorance. The effects are there, they can be measured, and instruments can be made which will register them. These measurements, however, must necessarily cover such a broad field that in all probability no one committee will even be able to arrive at any conclusions worth speaking about. Your committee must ask to be excused if they have found it beyond their power to present to the association any original matter, but have resorted to the old trick of embracing in this report a résumé of the facts presented and the experience gained by others, and compiling this information so as to represent our present knowledge on the extremely erratic action of motive power on bridges.

The attempted determination of impacts can be divided into three classes,—

1. Those which are purely theoretical and which are of no interest to this association.

2. Those which had for their object the measurement of the stretch of the various members of a bridge during the passage of trains. These tests are practically limited to those made by European investigations on riveted bridges, the results of which indicated that impacts decreased as the length of the span increased, and in a rather uncertain and erratic manner that impacts in the various members of the same span are a vague function of the length of moving load required to cause the maximum strain in the member considered. Members of your committee made about one hundred tests of this character, but results were not sufficiently positive to justify their presentation in this report.

3. Those which had for their object the measurement of the deflection of the structure as a whole.

Among investigators who have endeavored to measure centre deflections by mechanical means, perhaps no one has gone further into the question than Prof. S. W. Robinson, M. Am. Soc. C. E., who invented an instrument which accurately measured the deflection of bridges. The results of Professor Robinson's experiments were presented before the American society at the June meeting, 1895, and show that the increase of strain due to vibrations caused by unbalanced locomotive drivers is 28 per cent. of the maximum strain caused by the passing train when statically considered. He observed also that the increased strains due to vibrations caused by the body of the train were 50 per cent. greater than the corresponding part of the train statically considered. Moreover, since he found certain cases in which the dynamic strains produced by the train load itself were greater than those caused by the engine, he was of the opinion that in designing bridges 50 per cent. should be allowed for impacts, instead of the 28 per cent. which he found in his diagram. He also found that the cumulative vibrations, depending upon certain relations between the load and bridge, were particularly prejudicial. Among these are the relation between the circumference of the driver and the panel length, and the relation between the wheel spacing and the panel length.

In actual practice it is the custom of different engineers to make variable allowance for the effects of impact. For example, some roads will assume that bridges under 100-ft. span are subjected to impacts of varying amounts, while spans of greater length are subjected to no impact. Others assume that the strains caused by live loads are twice as great as those caused by the dead load only, regardless of the length of span. Some specifications allow a certain impact

varying from 100 per cent. for very short spans to nothing for spans of 500 feet and over. Others, again, will allow for varying impacts depending upon the ratio of the minimum stress to the maximum.

All these attempts to establish a law of impact, and the assumption of such laws as given in the various bridge specifications, while undoubtedly indicating the unsettled knowledge of the subject, are nevertheless more or less valuable, and tend toward safe construction. It is to be hoped that in the near future a sufficient number of tests will be made to indicate in some definite manner which, if any, of the numerous assumptions are approximately correct.

(Signed) GEO. W. ANDREWS.
J. E. GREINER.
WALTER G. BERG.

DISCUSSION.

Mr. Berg.—I regret that the two members of this committee, Mr. G. W. Andrews and Mr. J. E. Greiner, who, practically, did all the work connected with the report are not here. They have been prevented from being present. I will call attention to the fact that the committee report that they had devised a special instrument and made over one hundred tests on bridges with fast moving trains, and wish to particularly explain that Mr. Greiner, assisted by Mr. Andrews, should have all the credit for the very large amount of work done in connection with this report. It does not appear for the reasons Mr. Greiner states in his letter. The results of the instrumental tests, despite the fact that over one hundred tests were made, are not sufficient to warrant drawing definite conclusions, hence no direct reference to these tests was made in the report. It is probable that Mr. Greiner will follow up this matter and report results of the tests whenever completed. The entire question is no doubt valuable, although possibly the consideration of it belongs to a different Association from ours, and I think, therefore, that all that can be done now is to accept the summary report of the committee. The problem is a very complex one. It will probably never be definitely solved, and all we can do is to ascertain the best practice of bridge builders and bridge engineers and follow their lead, which will generally be in the line of either reducing the allowable unit stress on the various members of a bridge most affected by the jar of rapidly moving trains, or else by increasing the total theoretical stress in such members proportional to the extra strain or work thrown on them.

Mr. J. E. Greiner, who was detained at the last moment and could not come to our meeting, has sent me the following letter, supplementing the more formal committee report on this subject:

The tests made by Mr. G. W. Andrews and myself on some Philadelphia Division bridges, B. & O. R. R., were made for the purpose of ascertaining the relative effects of two different types of engines on certain bridges on the Philadelphia Division, varying in length from fifty-eight to five hundred and fifteen feet.

There were two special cars attached to two engines of different types, and each train was run over the bridge at a speed of ten miles per hour and then at a speed of thirty-five miles per hour. The relative elongations in different members were measured by instruments which I designed and had made for that particular purpose.

While the results of these tests show conclusively that one type of engine was more favorable to the bridge than the other, no general conclusion can be drawn from the tests so far as impacts are concerned; for this reason, I deemed it best not to enter into any details concerning them in the report submitted to the Association.

VIII. Best and Most Economical Railway Track Pile-driver.

REPORT OF G. W. HINMAN.

To the President and Members of the Association of Railway Superintendents of Bridges and Buildings:

Not being able to communicate with Mr. J. L. White, the chairman of your Committee, of which I am a member, on the subject of "The Best and Most Economical Railway Track Pile-Driver," I beg to submit the following:

I herewith hand you a blue-print of the Louisville & Nashville Railroad Company's track pile-driver. This style of pile-driver has been in use on the Louisville & Nashville Railroad for the last twelve years. This pile-driver was designed by the Bridge and Building department. You will note that it is a pendulum driver; piles can be driven on any batter, or plumb. You will also note that the driver has two centres, you can drive piles close to the end of the car, or shift the driver ahead on to the forward centre, and drive piles fifteen feet ahead of the car in case of a washout. You will also note that when the driver is on her back centre, you can swing the driver around, and work from the other end of the car. This is a very important feature in a driver when you are between two washouts and cannot get to a turn-table, or a Y, to turn the driver on.

The leads are raised and lowered with the aid of a pole twenty feet long. This pole is made with a yoke on the bottom end, and fastens to the leads by the means of two steel pins one and one-half inches in diameter, and ten inches long. It is adjustable. The top of the pole has two eye-bands. One eye-band is used for the suspension rope that holds the pole in position, the other end of the rope being fastened to the top of the leads. One end of the raising line is fastened to the other eye-band, and runs through a leading block which is made fast to a chain that is put under the track twenty-five feet ahead of the driver. The raising line runs from the leading block to sheave on for-

ward end of driver, back to winch head on engine. This handles the leads by steam, and it can be done very quickly and easily.

Any kind of engine can be used on this driver. All that is wanted is an engine with a hoisting drum and a winch head. I am using a double engine, with seven-inch cylinders, and two friction drums and two winch heads, made by the Lidgerwood Manufacturing company, of New York, No. 71. I use no nippers to raise the hammer, but make the line fast to the hammer, and handle it with the friction. The hammer weighs 3,300 pounds, which is, I think, the best weight for all kinds of pile driving. We use a two and one-half inch diameter, four strand, best Manilla rope for hammer line. I like it best for all purposes, and consider it better than a wire one. We carry on the driver a water-tank that will hold 300 gallons of water, and also a coal-box that will hold twenty-five bushels of coal. In working the driver, we couple the locomotive direct to the pile-driver with a long shackle made for that purpose, the tank of the locomotive being next the driver. This enables us to get water from the locomotive tank to the tank on driver by the aid of a steam syphon. We also use the syphon to fill the locomotive water-tank, when we can get water nearer than to run to a regular water station. We also get coal from the locomotive tender.

We also carry a tool-car with the driver. Twenty-four feet of this car is boxed up for tools; ten feet of car is open for coarse tools, pile rings, and a hand-car, which we always carry.

The tool-car contains the following tools:

500 feet of 2½-inch diameter best four strand manilla rope.
250 feet of 2-inch diameter best four strand manilla rope.
1 coil of ¼-inch diameter rope, 800 feet.
300 feet of 1-inch rope.
300 feet of ⅞-inch rope.
2 good switch ropes.
1 pair 8-inch patent, double sheave tackle blocks.
1 pair 12-inch patent, double sheave tackle blocks.
1 pair 16-inch patent, double sheave tackle blocks.
1 12-inch snatch block.
1 16-inch snatch block.
2 band pullers.
2 15-ton hydraulic, foot-lifting jacks.
4 10-ton screw jacks, 18 inches high.
2 5-ton screw jacks, 12 inches high.
6 steel bars, 5½ feet long.
4 steel bars, 4½ feet long.
2 claw bars.
4 track chisels.
2 14-pound double-faced mauls.
2 8-pound double-faced mauls.
6 5-feet cross-cut saws.
12 8-inch mill saw files.
8 6-pound chopping axes.
2 ship carpenters' hewing axes.
10 cant-hooks.
3 15-16-inch crank augers.
3 13-16-inch crank augers.
2 11-16-inch crank augers.
1 keg 10d. nails.
1 keg 30d. nails.
2 kegs track spike.
2 kegs 8x⅜-inch boat spike.

2 spike mauls.
1 track gauge.
2 7-8-inch S. wrenches.
4 3-4-inch S. wrenches.
2 5-8-inch S. wrenches.
1 12-inch monkey-wrench.
1 15-inch monkey-wrench.
1 18-inch monkey-wrench.
And wrenches to fit all the nuts on the pile-driver.
3 pairs adjustable pipe tongs.
1 hand hammer.
3 cold chisels.
2 12-inch flat files.
10-gallon can lubricating oil.
10-gallon can signal oil.
2 small oiling cans.
1 lamp filler.
8 white lanterns.
2 green lanterns.
2 red lanterns.
1 grindstone and frame.
1 hand-car.
1 velocipede car.
50 pile rings of various sizes to fit piles, made of good iron, 1 inch thick, 2½-inch wide.

For engine in pile-driver we carry:

5-gallon can of lubricating oil.
2-gallon can of cylinder oil.
1 pint oil can locomotive pattern.
1 squirt can.
1 soft hammer.
1 packing hook.

And wrenches to fit all the nuts on engine.

The above list of tools are necessary for the outfit of a road pile-driver.

The cost per day for running a pile-driver is as follows:

Foreman and ten men	$22.00
Engineer, fireman, and watchman	6.80
Conductor and two flagmen	7.00
Coal, oil, and waste	2.50
Use of locomotive	12.00
For use of driver and tools	2.50
	$52.80

This crew is for work on road where you are building short trestles, say from 30 to 40 piles each. Where a trestle is three or four thousand feet long the pile-driving crew should consist of a foreman and fourteen men, as there will not be so much delay in passing trains, as trestles of this length invariably have a side-track near both ends and consequently the pile-driver will drive more piles.

My pile-driver was rebuilt this year, and before rebuilding her several of the most improved railway pile-drivers were visited and examined to see if any improvements could be made on our driver. We found none. Taking into consideration the different kinds of work our driver can do, driving piles on any batter, changing centres,

and driving piles 15 feet ahead of car, also changing ends and driving on either end of our car, as well as using her for a derrick in loading and unloading all kinds of material with a boom I have rigged on her for that purpose, I am satisfied that the Louisville & Nashville Railway Company have the best and most economical railway track pile-driver.

Respectfully submitted,
G. W. HINMAN,
Supervisor B. & B., L. & N. R. R.

Evansville, Ind., Oct. 15, 1896.

DISCUSSION.

Mr. Aaron S. Markley.—We have a Bay City pile-driver in service about 5 or 6 years. It is self-propelling. If pile-driving is to be done within a mile and a half of a side-track, we rarely use an engine to propel the driver. In that way we save the expense of train crew, engineer, and fireman. We are protected by the train despatcher and get orders the same as if we had a regular train crew. We haul 5 or 6 cars on a level grade and 2 or 3 on our heaviest grade. All our unloading of sand, cement, and stone for masons, as well as similar work, is done with the driver. We pay our engineer $2.50 per day while running the driver. That saves, of course, the expense of labor referred to. When I first began using it I did not like it, but the longer we use it, the better we like it. I am safe in saying that in 5 or 6 years' service we have saved in train service the original cost of the machine. The price of the machine is $4,500. There are no repairs to amount to anything, the chains and sprocket-wheels are about the only thing that require renewing. They last from one to one and one-half years. The hammer line is hitched direct from the drum to the hammer. No cat-head is used. Forty to 50 piles can be driven per day, depending on location and number of trains with which we have to contend. Hammer which weighs 2,800 pounds is used. We tried wire cable, five-eighths, for hammer line, but found it too rigid. Ordinarily, the driver in running will make 8 miles per hour.

Mr. Thompson.—I have one of the Bay City drivers, which we bought about six years ago. When we got it I did not like it, and the more I use it the less I like it. It was called a self-propeller, but could only run about four miles per hour on good track. On sharp curves or when entering sidings, it could not

move itself. We do not pretend to use it without an engine to handle it. It is a very heavy, cumbersome affair, and I think a driver could be built of a great deal less material that would be much better. It is very hard on hammer lines. Mr. Markley says a line lasts him three or four weeks. We think we are doing well to make one last three or four days.

President.—The Duluth & Iron Range road has a Bay City driver. We liked it when we got it, and we still like it. We had some trouble about the rope, but the difficulty was in the construction of the head-block. We had three times more weight than was necessary. We readjusted the head-block and have had no further trouble. We use one and three-quarter-inch stevedore rope, as we find that the best rope. We used in one season a whole coil of manilla, in thirty days, then we bought stevedore and one coil lasted us six months.

Mr. Markley.—Did the old stevedore rope have a core in it?

President.—No.

Mr. Markley.—We find that the core dropped and that disturbed everything.

Mr. Eggleston.—We have got a Bay City driver and the longer we have it, the better we like it. It is not self-propelling. We use one and three-quarter-inch manilla rope with 3,000 pound hammer, and we have run these ropes in all kinds of weather. I do not know but the propeller would work well in some places, but most of our work lies away a good distance from any siding.

Mr. Bishop.—The Rock Island pile-driver is of their own plan, and their own build; has a 20-foot extension. The top and bottom sheaves are 14 inches; drum of engine is 20 inches. We use 1½-inch rope, and it drives about 150 piles before wearing out.

Mr. McNab.—The West Michigan pile-driver is one of their own design. It used to be so that it propelled itself, but we found there was not very much economy in doing so; it would only make about six or eight miles an hour, and in going up grades of any length the boiler would not make steam as fast as it used it, and we had to stop occasionally and blow up. We did away entirely with the propelling gear, and now we use an engine and crew every time we go out to drive piles.

We use a 2,800-pound hammer; our driver swings nine feet each way from centre of track.

Mr. Garvey.—What kind of a rope have you used?

Mr. Bishop.—We use manilla rope.

Mr. Garvey.—We have had considerable trouble with ropes wearing out. We now use manilla rope, but from what I have heard to-day I think there must be something wrong with our sheaves; sometimes the rope would not run more than two or three days. We use 14 x 12 sheaves. We have on our road a great many private telephone wires which cross the track, and there is hardly any station where we do not have to lower the leads when we go out, but we have them so regulated that we can raise and lower them easily. We do the most of the raising and lowering with the weight of the hammer, and we find it is very good to have the hammer fixed that way.

Mr. Thompson.—Have any of the members ever tried two-inch line, and have they used it for hoisting by hand or steam?

Mr. Bishop.—I find they are not giving good satisfaction on the pile-driver we got. At the present time I am figuring to rig up one with compressed air which will save two men.

Mr. Markley.—There is no danger with the hammer, but there is with the pile-driver.

Mr. J. H. Travis.—We have always had better results with 1½-hammer line than with any other size, and we have a great deal of driving to do on the Southern lines, where there are four or five miles of trestle at a place. We tried one and three-fourths and two inches, but we never did get as good results as we did from the one and one-half inch. In connection with this talk in reference to pile-drivers and their operation, I believe if we would all try to get up something that is better than we have had heretofore, it would be of more advantage and interest to the society than anything else. The great objection to all the pile-drivers that have been used in the Northern country within the last year is, that they have been turn-table drivers with fixed leads so that you can only drive your pile perpendicular at whatever distance from centre to centre that you wish. Some of the swing leads are very clumsy and there are a good many unnecessary parts about them, and I believe a pile-driver that has

better advantages than any we have yet seen can be constructed economically and have the leads to swing as well as a pendulum driver. I am going to try it on one driver that we are going to build, by making a frame that will support the leads, and so you can raise the leads if necessary when the train is in motion. It is very seldom that this is necessary, but by dropping the hammer the weight of the same raises the leads. I am going to make one side of the frame with a 4-inch screw, allowing an adjustment in one part of the frame of four inches, and that would be all that is necessary, I think. I have not made any experiments yet that would enable me to know just how long the screw should be, but four inches would be all that would be necessary, I think. I expect to have one in operation before very long, and next time I shall be able to tell the members how it works. I know that our chief engineer and all our managing officials insist on having two piles well battered so as to have a good base of support, and it would wreck the old-fashioned pile-drivers to do that.

IX. Span Limits for Different Classes of Iron Bridges and Comparative Merits of Plate-Girders and Lattice-Bridges for Spans from 50 Feet to 110 Feet.

REPORT OF W. A. McGONAGLE.

Mr. President.—As chairman of this committee, I will state that this subject was given us in 1894. Your committee have looked into the matter and find that the American Society of Civil Engineers discussed a similar subject, and a report on the same was read by Mr. J. A. L. Waddell in the year 1892, before that society. It occurs to your committee, that the discussion of this technical subject does not properly belong to our association; we should propound and discuss practical subjects relative to the maintenance department of our railroads, so that every member can fully understand and participate in the discussion thereof, and for this reason we have decided to give the usual practice of eminent engineers in the selection of classes of iron bridges for different spans.

Mr. J. A. L. Waddell, member A. S. C. E., recommends as follows:

Plate-girders	to 100 ft. span.
Lattice-girders	100 ft. to 150 ft. span.
Pin spans	150 ft. and upwards.

Mr. Edwin Thatcher, Keystone Bridge works, recommends as follows:

Plate-girders	to 90 ft. span.

Mr. Woelfel, Pencoyd Bridge works, recommends as follows:

Plate-girders	to 80 ft. span.
Lattice-girders	80 ft. to 110 ft. span.

Mr. J. S. Deans, Phœnix Bridge Co., recommends as follows:

Plate-girders	to 75 ft. span.
Lattice-girders	75 ft. to 135 ft. span.
Pin spans	135 ft. and upwards.

Mr. Aug. Ziesing, Lassig Bridge and Iron works, recommends as follows.

For deck spans	Plate-girders	. to 90 ft. or possibly 100 ft.
	Lattice-girders	from 90 ft. to 160 ft.
	Pin spans	. from 160 ft. and upwards.
For through spans	Plate-girders	to 80 ft. span.
	Half through lattice . . .	80 ft. to 110 ft. span.
	Full through lattice . . .	100 ft. to 160 ft. span.
	Pin spans	160 ft. and upwards.

Mr. Samuel Tobias Wagner, First Assistant City Engineer, Philadelphia, recommends as follows:

Plate-girders	to 80 ft. span.
Lattice-girders	80 ft. to 125 ft. span.
Pin spans	125 ft. and upwards.

From the above tabulations it will be observed that considerable difference exists among engineers as to the limits of spans for different classes of iron bridges, and your committee realize that location and head room are large determining factors in selecting classes of bridges and fixing length of spans to be used; and as we are called on to maintain these structures only, we must leave to the American Society of Civil Engineers the discussion of this important and very interesting subject, well knowing that among the members of that society are some of the brightest minds and keenest judgments of any society in this or any other country in the world.

W. A. McGonagle,
R. M. Peck,
W. M. Noon,
H. E. Gettys,
G. J. Bishop,
Onward Bates.

LIST OF ANNUAL CONVENTIONS.

First Convention,	St. Louis, Mo.,	September 25, 1891.
Second Convention,	Cincinnati, Ohio,	October 18, 19, 1892.
Third Convention,	Philadelphia, Penn.,	October 17 to 19, 1893.
Fourth Convention,	Kansas City, Mo.,	October 16 to 18, 1894.
Fifth Convention,	New Orleans, La.,	October 15, 16, 1895.
Sixth Convention,	Chicago, Ill.,	October 20 to 22, 1896.

MEMBERSHIP.

Year 1891-2. . . .	Number of active members, 60.
Year 1892-3. . . .	Number of active members, 112.
Year 1893-4. . . .	Number of active members, 128.
Year 1894-5. . . .	Number of active members, 115.
Year 1895-6. . . .	Number of active members, 122.
Year 1896-7. . . .	Number of active members, 140.

LIST OF OFFICERS OF THE ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS FROM THE ORGANIZATION OF THE ASSOCIATION TO THE YEAR 1896-'97.

YEAR.	1891-2.	1892-3.	1893-4.	1894-5.	1895-6.	1896-7.
President	O. J. Travis	H. M. Hall	J. E. Wallace	Geo. W. Andrews	W. A. McGonagle	James Stannard
First Vice-President	H. M. Hall	J. E. Wallace	Geo. W. Andrews	W. A. McGonagle	L. K. Spafford	Walter G. Berg
Second Vice-President	J. B. Mitchell	G. W. Hinman	W. A. McGonagle	L. K. Spafford	James Stannard	Joseph H. Cummin
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Secretary	C. W. Gooch	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	George M. Reid	George M. Reid	George M. Reid	George M. Reid	George M. Reid	N. W. Thompson
Executive Members	W. R. Damon	G. W. Andrews	Quintine McNab	James Stannard	R. M. Peck	W. O. Eggleston
	G. W. Markley	Joseph M. Staten	Aaron S. Markley	James H. Travis	J. L. White	W. M. Noon
	W. A. McGonagle	J. M. Caldwell	Floyd Ingram	Joseph H. Cummin	A. Shane	Joseph M. Staten
	G. W. McGehee	Quintine McNab	James Stannard	R. M. Peck	Aaron S. Markley	George J. Bishop
	G. W. Turner	Floyd Ingram	James H. Travis	J. L. White	W. M. Noon	C. P. Austin
	J. E. Wallace	Aaron S. Markley	Joseph H. Cummin	A. Shane	Joseph M. Staten	M. Riney

COMMITTEES ON SUBJECTS FOR REPORT AND DISCUSSION SELECTED AT EACH CONVENTION SINCE ORGANIZATION OF THE ASSOCIATION IN 1891.

FIRST CONVENTION, ST. LOUIS, MO., SEPTEMBER 25, 1891.

Subjects.	Committees.
1. Surface Cattle-Guards	Aaron S. Markley, J. B. Mitchell, W. R. Damon.
2. Frame and Pile Trestles Complete, including Rerailer	H. M. Hall, W. A. McGonagle, G. W. McGehee.
3. Framing and Protection of Howe Truss and Other Wooden Bridges against Fire and Decay	J. E. Johnson, G. W. Markley, J. H. Markley.
4. Iron and Vitrified Pipe for Waterways under Railroad Embankments	James Stannard, J. O. Thom, J. E. Wallace.
5. Water-Tanks Complete, including Painting, Pumps, Pump and Coal Houses, Wells and Reservoirs	G. W. Turner, R. K. Ross, Q. McNab.
6. Interlocking Signals	B. F. Bond, G. M. Hinman, James DeMars.
7. Depot Platforms, Complete	J. A. Nicholson, Adam McNab, C. B. Keller.
8. Paints for Iron Structures	Geo. M. Reid, A. J. Kelley, H. A. Hanson.

SECOND CONVENTION, CINCINNATI, O., OCTOBER 18 AND 19, 1892.

Subjects.	Committees.
1. Discipline, and Benefits Derived, and Who are the Beneficiaries	Geo. W. Andrews, W. R. Damon, T. M. Strain, G. W. Turner.
2. Turn-table, Best, with a View of Economy, and Durability, and Strength	G. W. Markley, H. F. Martin, James H. Travis, Charles Walker.
3. Water Columns, Best, Cheapest, Simplest, and Most Durable	C. E. Fuller, A. S. Markley, H. N. Spaulding, E. L. Cary.
4. Coaling Stations, including Storage Bins and for Coaling Engines	J. E. Wallace, C. W. Gooch, G. W. Hinman, J. H. Cummin.

5.

Crawling of Rails, and its Effects on Structures...... Geo. M. Reid, L. K. Spafford, J. B. Mitchell, L. S. Isdell.

6.

Guard-Rails on Bridges, Advantages and Disadvantages, and Best to be Adopted........................ O. J. Travis, Q. McNab, J. F. Mock, J. M. Staten.

7.

Platforms, Height and Distance from Rail and Mode of Construction.. James Stannard, M. Walsh, N. M. Markley, Robert Ogle.

8.

Best Bridge, Wood, Combination, or Iron, from 130 feet and upwards, and the Best Method of Reconstruction.. A. Shane, Walter Ransom, N. Potter, C. G. Worden.

9.

Best Method of Elevating Track upon Bridges and Trestles............. .... H. E. Gettys, S. F. Patterson, G. W. Hinman, P. A. Watson.

THIRD CONVENTION, PHILADELPHIA, PA., OCT. 17, 18, AND 19, 1893.

1.

Depressed Cinder Pits and Other Kinds............... W. G. Berg, Abel S. Markley, G. W. Andrews, C. E. Fuller.

2.

Best Method of Bridge Inspection..................... G. M. Reid, J. M. Staten, E. T. Wise, J. S. Berry.

3.

Pumps and Boilers.. G. W. Markley, G. W. Turner, J. B. Mitchell, J. R. Harvey.

4.

Maintenance of Pile and Frame Trestle............... W. A. McGonagle, J. H. Markley, Geo. C. Nutting, John Copeland.

5.

The Best Scale Foundation............................. O. J. Travis, Joseph Doll, C. E. Wadley, T. M. Strain.

FOURTH CONVENTION, KANSAS CITY, MO., OCT. 16, 17, AND 18, 1894.

1.

Mechanical Action and Resultant Effects of Motive Power at High Speed on Bridges.................... G. W. Andrews, W. G. Berg, J. E. Greiner, E. H. R. Green.

2.

Methods and Special Appliances for Building Temporary Trestles over Washouts and Burnouts...... R. M. Peck, G. J. Bishop, A. B. Manning, C. D. Bradley.

3.

Strength of Various Kinds of Timber Used in Trestles and Bridges, Especially with Reference to Southern Yellow Pine, White Pine, Fir, and Oak... W. G. Berg, J. H. Cummin, John Foreman, H. L. Fry.

4.

Best Method of Erecting Plate-Girder Bridges....... { H. M. Hall, J. M. Staten, G. W. Hinman, J. N. Pullen.

5.

Best and Most Economical Railway Track Pile-Driver.. { J. L. White, A. C. Davis, J. F. Mock, James T. Carpenter.

6.

Sand Dryers, Elevators, and Methods of Supplying Sand to Engines, including Buildings............... { Aaron S. Markley, H. A. Hanson, A. J. Kelley, J. O. Thorn.

7.

Span Limits for Different Classes of Iron Bridges, and Comparative Merits of Plate-Girders and Lattice-Bridges for Spans from 50 to 110 feet............ { W. A. McGonagle, R. M. Peck, W. M. Noon, H. E. Gettys.

8.

Best Method of Spanning Openings too Large for Box Culverts, and in Embankments too Low for Arch Culverts... { James Stannard, L. K. Spafford, O. H. Andrews, F. W. Tanner.

9.

Best End Construction for Trestle Adjoining Embankments... { G. M. Reid, J. L. Soisson, N. M. Markley, R. J. Howell.

10.

Interlocking Signals.................................... { J. H. Travis, W. S. Danes, R. L. Heflin, J. A. Spangler.

11.

Pumps and Boilers.. { John H. Markley, O. J. Travis, A. Shane, G. W. Markley.

FIFTH CONVENTION, NEW ORLEANS, LA., OCTOBER 15 AND 16, 1895.

1.

How to Determine Size and Capacity of Openings for Waterways... { Aaron S. Markley, J. S. Berry, C. C. Mallard, J. L. White.

2.

Different Methods of Numbering Bridges. Should All Waterways be Numbered?...................... { A. Shane, W. O. Eggleston, J. L. Soisson, O. J. Travis.

3.

Drawbridge Ends, Methods of Locking; and under this head include Locking of Turn-tables........... { H. M. Hall, James Stannard, H. Middaugh, C. C. Mallard.

4.

Protection of Trestles from Fire, including Methods of Construction................. .... { R. M. Peck, T. H. Kelleher, A. McNab, W. M. Noon, G. W. Hinman, William Berry.

5.

Local Stations for Small Towns and Villages, giving Plans of Buildings and Platforms.................... { J. H. Cummin, N. M. Markley, J. H. Markley, C. G. Worden.

6.

Tanks, Size, Style, and Details of Construction, including Frost-proof protection to Tank and Pipes.. — W. O. Eggleston, W. M. Noon, A. McNab, N. W. Thompson.

7.

Shearing of Rivets in Plate-Girders and Cause Thereof.. .... — J. M. Staten, R. L. Heflin, J. H. Travis, G. M. Reid.

8.

Best and Uniform System of Report Blanks for Bridge and Building Department.................... — G. J. Bishop, W. O. Eggleston, Onward Bates, M. Riney.

9.

Protection of Railroad Structures and Buildings from Fire... — R. M. Peck, L. K. Spafford, B. T. McIver.

10. Brought forward from 1894.

Mechanical Action and Resultant Effects of Motive Power at High Speed on Bridges.................... — G. W. Andrews, W. G. Berg, J. E. Greiner, E. H. R. Green.

11. Brought forward from 1894.

Best and Most Economical Railway Track Pile-Driver .... — J. L. White, A. C. Davis, J. F. Mock, J. T. Carpenter, G. W. Hinman.

12. Brought forward from 1894.

Span Limits for Different Classes of Iron Bridges, and Comparative Merits of Plate-Girders and Lattice-Bridges for Spans from 50 to 110 feet............ — W. A. McGonagle, R. M. Peck, W. M. Noon, H. E. Gettys, G. J. Bishop, Onward Bates.

13. Brought forward from 1894.

Interlocking Signals.................................. — J. H. Travis, W. S. Danes, R. L. Heflin, J. A. Spangler.

SIXTH CONVENTION, CHICAGO, ILL., OCTOBER 20, 21, AND 22, 1896.

1.

Methods of Heating Buildings where Three or More Stoves are Now Used................................. — J. H. Cummin, George W. Hinman, George W. Markley, Wm. Berry.

2.

The Most Suitable Material for Roofs of Buildings of All Kinds... — R. M. Peck, G. W. Turner, W. M. Noon, N. W. Thompson.

3.

Roundhouse Construction, including Smoke-jacks and Ventilators.. — Geo. W. Andrews, O. J. Travis, W. O. Eggleston, James T. Carpenter.

4.

Care of Iron Bridges after Erection.................... — James H. Travis, T. M. Strain, H. M. Hall, Walter Rogers.

5.

How to Determine Size and Capacity of Openings for Waterways..	Walter G. Berg, Aaron S. Markley, Onward Bates, A. J. Kelley.

6.

Protection of Railroad Buildings and Other Structures from Fire..	W. A. McGonagle, M. M. Garvey, J. D. Hilderbrand, John Foreman.

7.

Designs for Ice-Houses..................................	W. B. Yereance, C. M. Large, J. H. Markley, Geo. W. Ryan.

8.

Best End Construction for Trestles adjoining Embankments..	C. C. Mallard, W. S. Danes, R. L. Heflin, A. C. Olney.

9.

Bridge Warnings for Low Overhead Structures.......	W. E. Harwig, M. A. Martin, E. H. R. Green, Joseph Doll.

10.

Stock-yards and Stocksheds, including all Details of Construction..	Geo. J. Bishop, W. R. Cannon, O. H. Andrews, James Brady.

11.

Floor System on Bridges, including Skew Bridges....	W. B. Guppy, C. P. Austin, C. W. Gooch, F. W. Tanner.

DIRECTORY OF MEMBERS OF THE ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.

OCTOBER, 1896.

ANDERSON, C. W., N. & W. R. R., Graham, Va.
ANDREWS, GEORGE W., Philadelphia Div. B. & O. R. R., 24 Chestnut St., Phila.
ANDREWS, O. H., St. Jo. & G. I. & K. C. Ry., Elwood, Kan.
APPLE, T. N., Cleveland & Pittsburgh Ry., Wellsville, Ohio.
AUSTIN, CYRUS P., B. & M. R. R., Medford, Mass.
BATES, ONWARD, C., M. & St. P. Ry., and M. & N. Ry., Chicago, Ill.
BERG, WALTER G., Lehigh Valley Ry., Jersey City, N. J.
BERRY, J. S., S. T. S. W. Ry., Tyler, Texas.
BERRY, WILLIAM, San Antonio & Arkansas Pass Ry., Yoakum, Texas.
BISHOP, GEORGE J., C., R. I. & P. Ry., Topeka, Kan.
BRICKER, J. A., Norfolk & Western Ry., Shenandoah, Va.
BRADLEY, C. D., St. L. & San Francisco Ry., Tex. Div., Fort Smith, Ark.
BOND, B. F., O. & M. Ry., Flora, Ill.
BOYCE, JOSEPH W., L. E. & St. L. C. R. R., Huntingburgh, Ind.
BRADY, JAMES, Chicago, Rock Island & Pacific Ry., Davenport, Iowa.
CANNON, W. R., C. R. I. & P. Ry., Herington, Kan.
CARMICHAEL, WILLIAM, U. Pac. R. R., Junction City, Kan.
CARPENTER, JAMES T., ...Lexington, Ky.
CARY, E. L., M. R. and B. T. R. R., Bonne Terre, Mo.
CAHILL, M. F., 412 C St., Lynchburg, Va.
CUMMIN, JOSEPH H., Long Island R. R., Long Island City, N. Y.
DAMON, W. R., Louisville, Nashville & St. L. Rd. Co., Huntingburgh, Ind.
DANES, WILLIAM S., Wabash R. R., Eastern Div., 102 Ewing St., Peru, Ind.
DAVIS, A. C., Birmingham, Shef. & Tenn. Riv. Ry. Co., Sheffield, Ala.
DOLL, JOSEPH, C., C., C. & St. L. Ry. Co., Batesville, Ind.
EGGLESTON, WILLIAM O., C. & Erie R. R., Huntington, Ind.
ENNES, I. R., South Carolina Ry., Branchville, S. C.
FLETCHER, HOLLAND W., C. & N. W. Ry., 22 5th Ave., Chicago, Ill.
FOREMAN, JOHN, Phila. & Read. R. R., Pottstown, Pa.
FRY, H. L., Cape Fear & Yankin Valley R. R., Greensboro, N. C.
FITZ, PATRICK M. J., C., C., C. & St. L. R. R., Sandusky, Ohio.
GARVEY, M. M., Iowa Central R. R., Marshalltown, Iowa.
GETTYS, HENRY E., Norfolk & Western Ry., Roanoke, Va.
GILBERT, JAMES, M. K. & Texas Ry., Parsons, Kansas.
GOOCH, C. W., Iowa Central R. R., Des Moines, Iowa.
GOLDMARK, HENRY, 1731 Monadnock Block, Chicago, Ill.
GREEN, E. H. R., Texas Midland R. R., Terrell, Texas.
GREEN, WILLIAM, Mich. Div., C., C., C. & St. L. R. R., Wabash, Ind.
GREINER, J. E., B. & O. R. R., Baltimore, Md.
GUPPY, B. W., B. & M. R. R., Boston, Mass.
HALL, H. M., Ohio & Miss. Ry., Olney, Ill.

HANKS, GEORGE E., Flint & Pere Marquette Ry., East Saginaw, Mich.
HANSON, H. A., C., C., C. & St. L. Ry. Co., Mt. Carmel, Ill.
HARVEY, JAMES R., St. L., I. M. & S. Ry., Little Rock, Ark.
HARWIG, WILLIAM E., Lehigh Valley R. R., Phillipsburg, N. J.
HEILDER, W. H., N. & W. Ry., Shenandoah, Va.
HEFLIN, R. L., B. & O. Ry., Grafton, W. Va.
HILDEBBRAND, J. D., A., T. & S. F. R. R., Chanute, Kansas.
HINES, E. D., Norfolk & Western Ry., Portsmouth, Ohio.
HOWELL, ROBERT J., Wheeling Bridge & Terminal Ry., Wheeling, W. Va.
HOUSTON, JOHN, Wilmington & Northern Ry., Springfield, Pa.
HINMAN, G. W., Louisville & Nashville R'd Co., Evansville, Ind.
INGALLS, F., Nor. Pacific R. R., Jamestown, N. D.
INGRAM, FLOYD, Louisville & Nashville R'd Co., Erin, Tenn.
ISAACS, JOHN D., Southern Pacific Co., San Francisco, Cal.
JENNINGS, J. C., Mich. Div., C., C., C. & St. L. Ry., Wabash, Ind.
JOHNSON, J. E., Toledo, St. Louis & Kansas City R'd, Frankfort, Ind.
KELLEHER, T. H., New Orleans & N. E. R'd Co., New Orleans, La.
KELLER, C. B., C., C., C. & St. L. Ry. Co., Cambridge City, Ind.
KELLEY, A. J., K. C. Belt Ry. Co., Kansas City, Mo.
KING, A. H., Union Pacific Ry., Cheyenne, Wyo.
KLUMP, G. J., C., C., C. & St. L. Ry., Mattoon, Ill.
KYSER, CHARLES W., Mo. Pacific R. R., El Dorado, Kansas.
LARGE, C. M., Erie & Pittsburgh Ry., Jamestown, Pa.
LOUGHERY, E., Texas & Pacific Ry., Marshall, Texas.
MARKLEY, AARON S., Chicago & Eastern Ill. R. R. Co., Danville, Ill.
MARKLEY, JOHN H., Toledo, Peoria & Western Ry. Co., Peoria, Ill.
MARKLEY, N. M., C., C., C. & St. L. Ry. Co., Arcanum, Ohio.
MARKLEY, G. W., C., C., C. & St. L. Ry. Co., Crawfordsville, Ind.
MARKLEY, ABEL S., Pittsburg & Western Ry. Co., Alleghany, Pa.
MALLARD, CHARLES C., Southern Pacific Ry., Algiers, La.
MANNING, A. B., M., K. & T. Ry., Parsons, Kansas.
MARTIN, M. A., M., K. & T. Ry., Parsons, Kansas.
MARTIN, F. R., Cleveland & Pittsburgh Ry., Wellsville, Ohio.
MCGEHEE, G. W., Mobile & Ohio R'd Co., Okolona, Miss.
MCGONAGLE, W. A., Duluth & Iron Range R'd Co., Two Harbors, Minn.
MCIVERS, B. T., St. Paul & Duluth Ry. Co., St. Paul, Minn.
MCINTYRE, JAMES, Mahoning Div. Erie R. R., Central Depot, Cleveland, Ohio.
MCNAB, A., Chi. & West Mich. Ry., Holland, Mich.
MIDDAUGH, H., Seattle, Lake Shore & Eastern Ry. Co., Seattle, Wash.
MIDWINTER, JOSEPH, D., G., H. & M. Ry. Co., Grand Rapids, Mich.
MILLENER, S. S., B. & O. Southwest R. R., Washington, Ind.
MITCHELL, W. B., N. Y., P. & O. R. R., Galion, Ohio.
MOCK, J. F., Ohio River R'd Co., Parkersburg, W. Va.
MCCURDA, JAMES, A., T. & Santa Fé R'd, Merceline, Mo.
NEFF, J. L., C. Nor. Pac. & C. Ry., 353 Grand Central Depot, Chicago, Ill.
NUTTING, GEORGE C., O. R. & C. R. R., Blacksburg, S. C.
NOON, W. M., Duluth, South Shore & Atlantic Ry., Marquette, Mich.
OLNEY, A. C., Charleston, S. C.
OLMSTEAD, J. O., Central Vermont R. R., St. Albans, Vt.
OSBORNE, FRANK C., Valley Ry., Cleveland, Ohio.
PASCO, W. F., Lehigh R. R., Easton, Pa.
PARKER, JOHN F., Southern California Ry., San Bernardino, Cal.
PATTERSON, SAMUEL F., Boston & Maine, Concord, N. H.
POTTER, M. F., C., C., C. & St. L. Ry. Co., Franklin, Ohio.
PULLEN, J. B., B. & O. Ry. S. W., Chillicothe, Ohio.
PECK, R. M., Missouri Pac. and St. L., I., M. & S. Ry., Pacific, Mo.

Ransom, Walter, Alabama Great Southern Ry., Birmingham, Ala.
Reed, William, Jr., Ill. Cent. R. R., Chicago, Ill.
Reynolds, Edward F., C. & N. W. Ry., Ashland, Wis.
Ross, R. K., Detroit, Lansing & Northern Ry., Iona, Mich.
Rogers, James, N. Y. C. & St. L. R. R., Fort Wayne, Ind.
Rogers, Walter A., C. M. & St. P. Ry., Chicago, Ill.
Ryan, George W., K. C., Fort Scott & Memphis Ry. Co., Thayer, Mo., Ore. Co.
Rhoads, E. F., C., C., C. & St. L. Ry., Springfield, Ohio.
Riney, M., C. & N. W. R. R., Barraboo, Wis.
Schenck, W. S., B. & O. R. R. (P. H. Div.), Connellsville, Pa.
Shane, A., C., C., C. & St. L. Ry. Co., 85 College Ave., Indianapolis, Ind.
Short, M. D., K. C. Belt R. R., Kansas City, Mo.
Soisson, J. L., Wheeling & Lake Erie Ry. Co., Norwalk, Ohio.
Smith, L. D., Eastern Div. N. & W. Ry., Petersburg, Va.
Smith, Gilman W., C. M. & St. P. Ry., Chicago, Ill.
Snow, J. P., B. & M. R. R., Boston, Mass.
Spangler, J. A., Pittsburg Div. B. & O. Ry., Washington, Pa.
Spafford, L. K., K. City, Fort Scott & Memphis Ry., Kansas City, Mo.
Spaulding, H. N., Cinc., Hamilton & Ind. Ry., Connersville, Ind.
Stannard, James, Wabash Ry., Moberly, Mo.
Strain, T. M., Wabash Ry., Decatur, Ill.
Staten, Joseph M., Ches. & Ohio Ry., Richmond, Va.
Tanner, Frank W., Missouri Pacific Ry., Atchison, Kansas.
Thorn, J. O., C., B. & Q. Ry. Co., Beardstown, Ill.
Thompson, N. W., P., F. W. & C. Ry., Western Div., Fort Wayne, Ind.
Tilley, Charles M., Mex. National R. R., Laredo, Texas.
Tippett, John B., P. & P. M. Ry., Peoria, Ill.
Titley, J. W., Ft. Worth & Denver City Ry., Clarendon, Texas.
Travis, James H., Ill. Cent. Ry., Chicago, Ill.
Travis, O. J., Elgin, J. & E. Ry., Joliet, Ill.
Turner, G. W., St. L. & San Francisco Ry., Springfield, Mo.
Vandergrift, C. W., C. & O. Ry., Huntington Div., Alderson, W. Va.
Waddell, Charles E., C. V. Div. N. & W. R. R., Pulaski City, Va.
Wallace, J. E., Wabash R. R., Springfield, Ill.
Ward, Thomas N., Ohio Valley Ry., Henderson, Ky.
Watson, P. N., Maine Central R. R., Bartlett, N. H.
Weed, J. A., Union Pacific Ry., Pendleton, Ore.
Welker, George W., W., W. & O. Div., R. & D. Ry., Alexandria, Va.
White, J. L., Claude, Tex.
Wise, E. T., Ill. Central Ry., Waterloo, Ia.
Wilkinson, Jonathan M., Cinc., Jackson & M. Ry., Van Wert, Ohio.
Worden, C. G., S. Cal. Ry. Co., Los Angeles, Cal.
Yerrance, Wm. B., West Shore R. R., West 42d St., Ferry, N. Y. City.

DECEASED MEMBERS.

DeMars, James, Wheeling & L. Erie R. R., Norwalk, Ohio.
Dunlap, H., Wabash R. R., Andrews, Ind.
Fuller, C. E., T. H. & I. R. R., Terra Haute, Ind.
Isadell, L. S., O. & M. R. R., Lawrenceburgh, Ind.
Tozzer, William S., C. & O. R. R., Cincinnati, Ohio.
Trautman, J. J., S. C. R. R., Edgefield, S. C.
Graham, T. B., Nor. Pac. Ry., Little Falls, Minn.
Reid, George M., L. S. & M. S., Cleveland, Ohio.

CONSTITUTION.

ARTICLE I.

NAME.

SECTION 1. This Association is known as the "Association of Railway Superintendents of Bridges and Buildings."

ARTICLE II.

OBJECT.

SECTION 1. The object of this Association shall be the mutual advancement of its members, by the acquirement of more perfect knowledge in the construction, maintenance, and repair of railroad bridges and buildings, as well as all other matters entrusted to the care of superintendents of bridges and buildings, by common discussion, interchange of ideas, reports, and investigations of its members.

ARTICLE III.

MEMBERSHIP.

SECTION 1. Any person at the head of a bridge and building department on any railroad, or a division or subdivision, and to include assistant superintendent and general foreman of any railroad, shall be eligible to membership in this Association upon application to the Secretary and the payment of $3.00 membership fee and $3.00 for one year's dues, membership to continue until written resignation is received by the Secretary, unless member has been previously expelled.

SEC. 2. Any member guilty of dishonorable conduct, or conduct unbecoming a railroad official and member of this Association, or who shall refuse to obey the chairman, or rules of this Association, may be expelled by a two-thirds vote of the members present.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of this Association shall be a president, four vice-presidents, a secretary, a treasurer, and six executive members. The executive members, together with the president, secretary, and treasurer, shall constitute the Executive Committee.

ARTICLE V.

DUTIES OF OFFICERS.

SECTION 1. The duties of officers shall be such as prescribed by by-laws, as pertain to officers of like character, general, or may be assigned them by the Executive Committee.

ARTICLE VI.

EXECUTIVE COMMITTEE.

SECTION 1. The Executive Committee shall exercise a general supervision over the financial and other interests of the Association, assess the amount of annual and other dues, call, prepare for, and conduct general or special meetings, make all necessary purchases and contracts required to conduct the general business of the Association, but shall not have power to render the Association liable for any debt beyond the amount then in the treasurer's hands not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the Association.

SEC. 2. The Executive Committee shall report the proceedings of its meetings, making such reports accessible to members; it shall publish the proceedings of all meetings of the Association, subject to the approval of the Association.

SEC. 3. Two thirds of the members of the Executive Committee may call special meetings, sixty days' notice being given members by mail.

SEC. 4. Five members of the Executive Committee shall constitute a quorum for the transaction of business.

ARTICLE VII.

ELECTION OF OFFICERS AND TENURE OF OFFICE.

SECTION 1. The officers, excepting as otherwise provided, shall be elected at the regular meeting of the Association, held on third Tuesday in October of each year, and the election shall not be postponed except by unanimous consent.

PRESIDENT AND TREASURER.

SEC. 2. The president and treasurer shall be elected by ballot by a majority of votes cast, and shall hold office for one year, or until successors are elected.

VICE-PRESIDENTS AND EXECUTIVE MEMBERS.

SEC. 3. The vice-presidents shall hold office for one year and executive members for two years, four vice-presidents and three executive members to be elected each year; provided, however, that three of the executive members be appointed by the president at the adoption of this constitution. All officers herein named to hold office until successors are chosen at next annual meeting.

SEC. 4. In the election of vice-presidents, each one shall be elected by a majority vote. Executive members will be elected in the same way, all voting to be by written ballots.

SECRETARY.

SEC. 5. A secretary shall be elected by a majority of the votes of the members present at the annual meeting. The term of office of the secretary shall be for one year, unless terminated sooner by action of the Executive Committee, two-thirds of whom may remove the secretary at any time. His compensation shall be fixed by a majority of the Executive Committee. The secretary shall also be secretary of the Executive Committee.

TREASURER.

SEC. 6. The treasurer shall be required to give bond in an amount to be fixed by the majority of the Executive Committee.

ARTICLE VIII.

COMMITTEES.

SECTION 1. At the first session of the annual meeting the president shall appoint a committee of three members, not then officers of the Association, who shall send names of nominees for officers of the Association for the ensuing year to the secretary, before the election of officers is in order, and the names shall be announced as soon as received. The election shall not be held until the day after announcement, except by unanimous consent. Nothing in this section shall be construed to prevent any members from making nominations.

AUDITING COMMITTEE.

SEC. 2. At the first session of each annual meeting there shall be appointed by the president an auditing committee of three members, not officers of the Association, whose duty it shall be to examine the accounts and vouchers of the treasurer and certify as to the correctness of his accounts. Acceptance of this committee's report will be regarded as the discharge of the committee.

COMMITTEES ON SUBJECTS FOR DISCUSSION.

SEC. 3. At each annual meeting there shall be appointed by the president a committee, whose duty it shall be to prepare and report subjects for discussion and investigation at the next annual meeting. If subjects are approved by the Association, the president shall appoint a committee to report on them. It shall be the duty of the committee to receive from members questions for discussion during the time set apart for that purpose. This committee shall be the judge of whether such questions are suitable ones for discussion, and if so, report them to the Association.

COMMITTEES ON INVESTIGATION.

SEC. 4. When the committee on subjects has reported and the Association approved of the same, the president shall appoint special committees to investigate and report on said subjects, and he may appoint a special committee to investigate and report on any subject which a majority of members present may approve of.

ARTICLE IX.

ANNUAL DUES.

SECTION 1. Every member shall pay to the treasurer three dollars membership fee, and shall also pay three dollars per year in advance to defray the necessary expenses of the Association. No member being one year in arrears for dues will be entitled to vote at any election, and any member one year in arrears may be stricken from the list of members at the discretion of the Executive Committee.

ARTICLE X.

AMENDMENTS.

SECTION 1. This constitution may be amended at any regular meeting by a two-thirds vote of members present, provided that a written notice of the proposed amendment has been given at least ninety days previous to said regular meeting.

BY-LAWS.

TIME OF MEETING.

1. The regular meeting of this Association shall be held annually on the third Tuesday in October.

HOUR OF MEETING.

2. The regular hour of meeting shall be at 10 o'clock a. m.

PLACE OF MEETING.

3. The cities or places for holding the annual convention may be proposed at any regular meeting of the Association before the final adjournment. The places proposed shall be submitted to a ballot vote of the members of the Association, the city or place receiving a majority of all the votes cast to be declared the place of the next annual meeting; but if no place received a majority of all votes, then the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

QUORUM.

4. At any regular meeting of the Association, fifteen or more members shall constitute a quorum.

ORDER OF BUSINESS.

5. 1st—Calling of roll.
2d—Reading minutes of last meeting.
3d—Admission of new members.
4th—President's address.
5th—Reports of secretary and treasurer.
6th—Payment of annual dues.
7th—Appointment of committees.
8th—Reports of committees.
9th—Unfinished business.
10th—New business.
11th—Reading and discussion of questions propounded by members.
12th—Miscellaneous business.
13th—Election of officers.
14th—Adjournment.

DUTIES OF OFFICERS.

6. It shall be the duty of the president to call the meeting to order at the appointed time; to preside at all meetings; to announce the business before the Association, and to decido all questions of order and sign all orders drawn on the treasurer.

7. It shall be the duty of the vice-presidents, in the absence of the president, to preside at all meetings of the Association, in their order named.

8. It shall be the duty of the secretary to keep a correct record of proceedings of all meetings of this Association; to keep correct all accounts between this Association and its members; collect all moneys due the Association, and pay the same over to the treasurer and take his receipt therefor, and to perform such other duties as the Association may require.

9. It shall be the duty of the treasurer to receive and receipt to the secretary for all moneys received from him, and pay all orders authorized by the Association.

DECISIONS.

10. The votes of a majority of members present shall decide any question, motion, or resolution which shall be brought before the Association, unless otherwise provided.

DISCUSSIONS.

11. All discussions shall be governed by Roberts' Rules of Order.

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REPORTS OF COMMITTEES ON INVESTIGATION FOR 1895–6.

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PROCEEDINGS

OF THE

SEVENTH ANNUAL CONVENTION

OF THE

Association of Railway Superintendents of Bridges and Buildings,

HELD IN DENVER, COLORADO,

OCTOBER 19, 20, AND 21, 1897.

CONCORD, N. H.:
THE RUMFORD PRESS.
1897.

OFFICERS FOR 1897-'98.

WALTER G. BERG, ... PRESIDENT.
Lehigh Valley Railroad, Jersey City, N. J.

JOSEPH H. CUMMIN, ... FIRST VICE-PRESIDENT.
Long Island Railroad, Long Island City, N. Y.

AARON S. MARKLEY, ... SECOND VICE-PRESIDENT.
Chicago & Eastern Illinois Railroad, Danville, Ill.

G. W. HINMAN, ... THIRD VICE-PRESIDENT.
Louisville & Nashville Railroad, Evansville, Ind.

C. C. MALLARD, ... FOURTH VICE-PRESIDENT.
Southern Pacific Railway, Algiers, La.

S. F. PATTERSON, ... SECRETARY.
Boston & Maine Railroad, Concord, N. H.

N. W. THOMPSON . . . . TREASURER.
Pittsburg, Fort Wayne & Chicago Railway, Fort Wayne, Ind.

EXECUTIVE MEMBERS.

GEORGE J. BISHOP, ... Topeka, Kan.
Chicago, Rock Island & Pacific Railway.

C. P. AUSTIN, ... Medford, Mass.
Boston & Maine Railroad.

M. RINEY. . . . . Barraboo, Wis.
Chicago & Northwestern Railway.

WM. S. DANES, ... Peru, Ind.
Wabash Railroad.

J. H. MARKLEY . . . . Peoria, Ill.
Toledo, Peoria & Western Railway.

W. O. EGGLESTON, ... Huntington, Ind.
Chicago & Erie Railroad.

PAST-PRESIDENTS.

O. J. TRAVIS, ... Chicago, Ill.
Illinois Central Railway.

H. M. HALL, ... Olney, Ill.
Ohio & Mississippi Railway.

J. E. WALLACE. . . . . Springfield, Ill.

GEO. W. ANDREWS, ... Wilmington, Del.
Baltimore & Ohio Railroad.

W. A. MCGONAGLE, ... Two Harbors, Minn.
Duluth & Iron Range Railroad.

JAMES STANNARD, ... Moberly, Mo.
Wabash Railroad.

COMMITTEES FOR 1897-'98.

COMMITTEES ON SUBJECTS FOR REPORT AND DISCUSSION.

1. Pile-rings and method of protecting pileheads in driving.

G. W. Hinman, Louisville & Nashville R. R.
Wm. S. Danes, Wabash R. R.
F. Eilers, Chicago, Burlington & Quincy R. R.
E. F. Reynolds, Chicago & Northwestern R. R.
Wm. Carmichael, Union Pacific R. R.
C. M. Large, Erie & Pittsburgh R. R.

2. Cost and manner of putting in pipe culverts.

Walter A. Rogers, Chicago, Milwaukee & St. Paul R. R.
Frank W. Tanner, Missouri Pacific R. R.
John H. Markley, Toledo, Peoria & Western R. R.
A. H. King, Union Pacific R. R.
B. F. Bond, Jacksonville & St. Louis R. R.
O. H. Andrews, St. Jo. & G. I. & K. C. R. R.

3. Best floors for shops and roundhouses.

A. W. Merrick, Chicago & Northwestern R. R.
C. S. Thompson, Denver & Rio Grande R. R.
Wm. O. Eggleston, Chicago & Erie R. R.
M. F. Cahill, Lynchburg, Va.
J. B. Pullen, Baltimore & Ohio Southwestern R. R.
James Gilbert, Missouri, Kansas & Texas R. R.

4. Roundhouse smokejacks and ventilation.

George W. Andrews, Baltimore & Ohio R. R.
Wm. O. Eggleston, Chicago & Erie R. R.
Aaron S. Markley, Chicago & Eastern Illinois R. R.
R. J. Howell, Wheeling Bridge & Terminal R. R.
J. T. Carpenter, Chicago, Rock Island & Pacific R. R.
A. McNab, Chicago & West Michigan R. R.

5. Cattleguards and wingfences.

C. C. Mallard, Southern Pacific R. R.
C. S. Thompson, Denver & Rio Grande R. R.
A. Zimmerman, Union Pacific, Denver & Gulf R. R.
L. H. Wheaton, The Coast Railway of Nova Scotia.
O. W. Osborne, Northern Pacific R. R.
R. L. Heflin, Baltimore & Ohio R. R.

6. Prevention of fire in railroad buildings.

John D. Isaacs, Southern Pacific R. R.
Wm. A. McGonagle, Duluth & Iron Range R. R.
M. Riney, Chicago & Northwestern R. R.
H. L. Fry, Cape Fear & Yadkin Valley R. R.
J. P. Snow, Boston & Maine R. R.
Wm. B. Yereance, West Shore R. R.

7. Storage of fuel, oil, and other station supplies at way-stations.

Arthur Montzheimer, Chicago & Northwestern R. R.
A. Shane, C., C., C. & St. L. R. R.
G. E. Hanks, Flint & Pere Marquette R. R.
J. E. Johnson, Toledo, St. Louis & Kansas City R. R.
W. Z. Taylor, Chicago, Burlington & Quincy R. R.
E. M. Gilchrist, Hannibal & St. Joseph R. R.

8. Railroad highway crossing gates.

Joseph H. Cummin, Long Island R. R.
J. B. Sheldon, New York, New Haven & Hartford R. R.
Wm. E. Harwig, Lehigh Valley R. R.
G. W. Smith, Chicago, Milwaukee & St. Paul R. R.
J. E. Featherston, Missouri Pacific R. R.
W. M. Noon, Duluth, South Shore & Atlantic R. R.

9. What repairs, and how can they be safely made, to metal and wooden spans without the use of falsework.

F. S. Edinger, Southern Pacific R. R.
B. W. Guppy, Boston & Maine R. R.
J. E. Greiner, Baltimore & Ohio R. R.
John D. Isaacs, Southern Pacific R. R.
Walter A. Rogers, Chicago, Milwaukee & St. Paul R. R.
H. W. Fletcher, Chicago & Northwestern R. R.

10. Care of iron bridges after erection, including best method of protecting them from injury by salt water drippings from refrigerator cars.

J. E. Greiner, Baltimore & Ohio R. R.
B. W. Guppy, Boston & Maine R. R.
James McIntyre, Erie R. R.
T. M. Strain, Wabash R. R.
A. J. Kelley, Kansas City Belt R. R.
L. F. Goodale, Hannibal & St. Joseph R. R.

11. Turntable construction.

Onward Bates, Chicago, Milwaukee & St. Paul R. R.
J. B. Sheldon, New York, New Haven & Hartford R. R.
D. K. Colburn, Southern Pacific R. R.
John Foreman, Philadelphia & Reading R. R.
E. Fisher, Missouri Pacific R. R.
Henry Goldmark, Chicago, Ill.

COMMITTEE ON APPLICATIONS FOR MEMBERSHIP.

Joseph H. Cummin, Long Island R. R., Long Island City, N. Y.
C. P. Austin, Boston & Maine R. R., Medford, Mass.
C. C. Mallard, Southern Pacific R. R., Algiers, La.
George W. Andrews, Baltimore & Ohio R. R., Wilmington, Del.

COMMITTEE ON MEMOIRS.

Walter G. Berg, Lehigh Valley R. R.
James Stannard, Wabash R. R.
Wm. A. McGonagle, Duluth & Iron Range R. R.
B. F. Bond, Jacksonville & St. Louis R. R.

SPECIAL COMMITTEE ON RELIEF.

James Stannard, Wabash R. R., Moberly, Mo.
H. M. Hall, Ohio & Miss. R. R., Olney, Ill.
W. M. Noon, Duluth, South Shore & Atlantic R. R., Marquette, Mich.
C. P. Austin, Boston & Maine R. R., Medford, Mass.
G. W. Hinman, Louisville & Nashville R. R., Evansville, Ind.
Aaron S. Markley, Chicago & Eastern Illinois R. R., Danville, Ill.

PROCEEDINGS OF THE SEVENTH ANNUAL CONVENTION

OF THE

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS,

HELD IN DENVER, COL., OCTOBER 19, 20, AND 21, 1897.

The convention was called to order at 10 a. m., October 19th, 1897, at the Brown Palace Hotel, Denver, Col., with President James Stannard in the chair, a number of ladies being present at the opening exercises.

PRESIDENT.—The hour has arrived for calling our seventh annual convention to order, and I will ask our second vice president, Mr. J. H. Cummin, to offer prayer. All members of the convention will please arise.

Prayer was then offered by Mr. Cummin.

PRESIDENT.—The first order of business is calling the roll. The secretary then called the roll, thirty-six answering to their names as follows:

ROLL-CALL.

O. H. ANDREWS, St. Jo. & G. I. & K. C. Ry., St. Joseph, Mo.
C. P. AUSTIN, Boston & Maine R. R., Medford, Mass.
WALTER G. BERG, Lehigh Valley Railroad, Jersey City, N. J.
GEO. J. BISHOP, Chicago, Rock Island & Pacific Railway, Topeka, Kan.
B. F. BOND, Jacksonville & St. L. Ry., Jacksonville, Ill.
WM. CARMICHAEL, Union Pacific Railway, Junction City, Kan.
J. T. CARPENTER, Chicago, Rock Island & Pacific Railway, Topeka, Kan.
J. H. CUMMIN, Long Island Railroad, Long Island City, N. Y.
W. S. DANES, Wabash Railroad, Peru, Ind.
W. O. EGGLESTON, Chicago & Erie Railroad, Huntington, Ind.
H. W. FLETCHER, Chicago & Northwestern Railway, Chicago, Ill.
JOHN FOREMAN, Philadelphia & Reading R. R., Pottstown, Pa.
G. E. HANKS, Flint & Pere Marquette Railway, East Saginaw, Mich.

WM. F. HARWIG, Lehigh Valley Railroad, Phillipsburg, N. J.
JOHN D. ISAACS, Southern Pacific Railway, San Francisco, Cal.
A. J. KELLEY, Kansas City Belt Railway, Kansas City, Mo.
A. H. KING, Union Pacific Railway, Cheyenne, Wyo.
C. C. MALLARD, Southern Pacific Railway, Algiers, La.
M. A. MARTIN, M. K. & T. Railway, Parsons, Kan.
JAMES MCINTYRE, Erie Railroad, Cleveland, O.
A. MCNAB, Chicago & West Michigan Railway, Holland, Mich.
W. M. NOON, Duluth, South Shore & Atlantic Railway, Marquette, Mich.
S. F. PATTERSON, Boston & Maine Railroad, Concord, N. H.
J. B. PULLEN, Baltimore & Ohio Railroad, Chillicothe, O.
E. F. REYNOLDS, Chicago & Northwestern Railway, Ashland, Wis.
M. RINEY, Chicago & Northwestern Railway, Barraboo, Wis.
W. A. ROGERS. C., M. & St. Paul Railway, Chicago, Ill.
A. SHANE, C., C., C. & St. L. Railway, Indianapolis, Ind.
JAMES STANNARD, Wabash Railroad, Moberly, Mo.
J. M. STATEN, Chesapeake & Ohio Railroad, Richmond, Va.
T. M. STRAIN, Wabash Railroad, Decatur, Ill.
F. W. TANNER, Missouri Pacific Railway, Atchison, Kan.
N. W. THOMPSON, P., F. W. & Chicago Railroad, Fort Wayne, Ind.
C. W. VANDERGRIFT, Chesapeake & Ohio Railroad, Alderson, W. Va.
WM. B. YEREANCE, West Shore Railroad, New York, N. Y.
A. ZIMMERMAN, U. P., D. & Gulf Railroad, Denver, Col.

The following seven applicants for membership, subsequently elected, were also present:

D. K. COLBURN, Southern Pacific Railroad, Houston, Tex.
FRED EILERS, C., B. & Q. Railroad, Ottumwa, Ia.
A. W. MERRICK, Chicago & Northwestern Railway, Huron, S. Dak.
ARTHUR MONTZHEIMER, Chicago & Northwestern Railway, Milwaukee, Wis.
J. B. SHELDON, N. Y., N. H. & H. Railroad, Woonsocket, R. I.
W. Z. TAYLOR, C., B. & Q. Railroad, Creston, Ia.
C. S. THOMPSON, Denver & Rio Grande Railroad, Denver, Col.

President.—The reading of the minutes of the last meeting is next in order.

Mr. Berg.—I move that the reading of the minutes be dispensed with, as they have been printed and placed in the hands of the members. Motion was seconded and carried.

President.—The Secretary will now read the minutes of the meetings of the Executive Committee.

REPORT OF MINUTES OF MEETING OF EXECUTIVE COMMITTEE, HELD IN CHICAGO, ILL., ON MARCH 10, 1897.

LELAND HOTEL, CHICAGO, ILL., March 10, 1897.

The meeting of the Executive Committee was called to order at 9:35 a. m. Chairman Eggleston in the chair.

Present: W. O. EGGLESTON, JAMES STANNARD, W. M. NOON, C. P. AUSTIN, W. S. DANES, N. W. THOMPSON, G. J. BISHOP, and M. RINEY.

Communication from the secretary was read, as an excuse for his absence.

Communication from W. G. Berg, and Professor Edgar Kidwell read, and referred to the next annual meeting.

Letter from President Stannard read in regard to memorials of our deceased members. The following resolution, presented by Mr. Stannard, was unanimously adopted:

WHEREAS, It is desirable and proper to prepare and embody in the report of our annual conventions suitable memorial notices of all deceased members of this association, such notices to contain a brief record of the principal facts connected with the life and practical experience of the deceased;

Resolved, That the secretary request such members, as were well acquainted with the deceased, to forward the necessary information so that separate notices can be prepared and reported by the Memoir Committee at our next annual convention.

Moved that George J. Bishop be a committee of one to make arrangements for the next annual convention to be held in Denver. Carried. Moved by President Stannard that the next convention be held in the Brown Palace Hotel on October 19 to 21st, 1897. Carried.

Letter from Mr. Bishop was read by him, giving the plan of side trips.

Moved, the secretary correspond with the Pullman and Wagner Car companies for one half rates to Denver, also for side trip to Glenwood Springs over the D. &. R. G. and A., T. & S. F. Railroads, and arrange for buffet car on this trip. Carried.

Moved that the business programme of our last meeting be adopted at our next meeting. Carried.

Moved, the secretary correspond with J. F. Mock in relation to his financial condition in paying his dues, and report at the next meeting. Carried.

On motion of Mr. N. W. Thompson, voted to pay our secretary $200 and expenses per year.

Moved that the president be instructed to make out a new blank application for new members, and forward the same to the secretary to be printed. Carried.

Moved that the president write out the programme and send to the secretary so he can print and send to the members 30 days before the meeting. Carried.

Moved that the president send a letter to Mrs. Spafford, expressing the regrets of the members of the association in regard to the decease of our member, Mr. L. K. Spafford. Carried.

Moved to adjourn, and was carried at 11:40 a. m.

C. P. AUSTIN,
Secretary Pro Tem.

President.—You have heard the reading of the report of the meeting of the executive committee. What is your pleasure?

Mr. Cummin.—I move that it be adopted as read. Motion was seconded and carried.

REPORT OF THE MEETING OF EXECUTIVE COMMITTEE, HELD AT BROWN PALACE HOTEL, DENVER, COL., ON OCTOBER 18, 1897.

Meeting called to order at 10:30 a. m. In the absence of the chairman of the Executive Committee, Mr. Stannard, president of the association, acted as chairman. Mr. Patterson was appointed to act as the secretary.

Present: MESSRS. STANNARD, PATTERSON, NOON, BISHOP, and RINEY. By resolution Mr. Berg was requested to attend the meeting.

The minutes of the last meeting of the Executive Committee held at Chicago, Ill., on March 10th, 1897, were read and approved.

The secretary presented a list of members in arrears for dues for more than one year. On motion, the secretary was instructed to inform all such members that unless the dues were paid within thirty days after such notification, they would be permanently dropped from membership, and the secretary was directed to carry out these instructions without further action of the Executive Committee.

The question was discussed, of publishing in the proceedings of the association, certain tables relative to the strength of timber beams and struts of various dimensions and spans, based upon the units of strength recommended by the Committee on Strength of Timber, which tables Professor Kidwell of the Michigan Mining School of Houghton, Mich., proposes to furnish to the association. Resolved, that the matter be referred to the secretary and the incoming president with instructions to correspond with Professor Kidwell, and express to him the great value that this association attributes to his suggestions, and that, if the expense is not prohibitive, the association will be glad to publish such tables in the proceedings; that further, the secretary, after ascertaining from Professor Kidwell the probable extent of the tables, obtain the approximate cost and thereupon take a letter vote of the members of the Executive Committee as to whether such extra expense should be incurred. If said vote is favorable, then the secretary is to proceed further in the matter and publish said tables in the proceedings.

Mr. Berg presented proof and a sample book of a republication of the technical reports and discussions contained in the proceedings from the first convention up to and including the present one, which republication is being made by the "Roadmaster and Foreman" of Chicago, Ill., without expense to this association, and under the general supervision of Mr. Berg. Resolved, that the "Roadmaster and Foreman" be authorized to republish the reports and discussions contained in the proceedings of this association from the first convention to the seventh convention, and that such republication receive the official sanction of the Association of Railway Superintendents of Bridges and Buildings.

Meeting adjourned at 12 m.

Signed,

S. F. PATTERSON,
Secretary.

President.—What is to be done with the report of the second meeting of the Executive Committee held here yesterday?

Mr. Patterson.—I move that it be adopted.

Motion was seconded and carried.

President.—The next in order is the report of the Committee on Applications for membership.

Mr. Berg.—Mr. President, I have the report of the Committee on Applications as presented by Mr. C. P. Austin of that committee. I move that, if no objections are made, the names as recommended by the committee be favorably voted on.

Motion was seconded and carried.

President.—I would advise that the secretary cast one vote for the new members.

Vote was cast, and the president declared the following fourteen applicants duly elected to membership:

D. K. Colburn, Southern Pacific Railway, Houston, Tex.
Fred S. Edinger, Southern Pacific Railway, San Francisco, Cal.
Fred Eilers, Chicago, Burlington & Quincy Railroad, Ottumwa, Ia.
J. E. Featherston, Missouri Pacific Railway, Osawatomie, Kan.
E. Fisher, Missouri Pacific Railway, Pacific, Mo.
Ed. M. Gilchrist, Hannibal & St. Joseph Railroad, Brookfield, Mo.
L. F. Goodale, Hannibal & St. Joseph Railroad, St. Joseph, Mo.
A. W. Merrick, Chicago & Northwestern Railway, Huron, S. Dak.
Arthur Montzheimer, Chicago & Northwestern Railway, Milwaukee, Wis.
A. W. Osborne, Northern Pacific R. R., Tacoma, Wash.
J. B. Sheldon, New York, New Haven & Hartford Railroad, Woonsocket, R. I.
W. Z. Taylor, Chicago, Burlington & Quincy Railroad, Creston, Ia.
C. S. Thompson, Denver & Rio Grande Railroad, Denver, Col.
L. H. Wheaton, The Coast Railway of Nova Scotia, Yarmouth, N. S.

President.—I appoint Mr. Austin to present new members.

The new members being presented, the president addressed them as follows: Gentlemen,—I am pleased to have you become members of our association and in behalf of the association I extend to you a cordial welcome. You will please be seated with the members.

A short recess was then taken for the purpose of welcoming the new members and also of paying annual dues.

Handsome association badges, presented to the association by the Sherwin-Williams Company, were distributed to the members.

After the recess the president delivered the annual address, as follows:

Officers and Members of the Association of Railway Superintendents of Bridges and Buildings:

I greet you all at this time, assembled as we are in this our seventh annual convention, in this beautiful city of Denver, situated at the foot-hills of the Rockies about one mile above sea-level.

I am pleased to see so many present.

Since we last met, hard times have been felt over our entire country; numerous banking houses have closed their doors, and their confiding depositors have been deprived of their hard-earned savings; business houses have been forced to make assignments; same causes have forced many factories to close down, depriving thousands of employment and means of providing for those dependent upon them; also many of the various railroad companies which we represent here to-day have felt heavily this great depression in business, and have been forced to introduce methods of strict economy to meet their fixed charges. The universal watchword has been retrenchment in all departments, which has thrown several of our members out of their former positions. Notwithstanding all this, our membership shows a healthy increase, and to-day we rank among the first of important railroad associations in way of interchange of practical experience and valuable information. I am sure that with the harmony that now exists and the undivided interest of all our membership, this association is destined to rank with the best of similar organizations of our country.

During the year just passed, the silent messenger has borne the mandate of death to some of the members of our association who have responded to the summons, which no one can disobey or postpone.

So far as I am advised, those who have passed away during the past year are as follows:

First: Lester K. Spafford, who died at Phœnix, Arizona, January 7th, 1897. His remains were returned to his home at Kansas City, Mo., where he was buried in Elmwood cemetery, January 11th. George J. Bishop, George W. Ryan, and myself attended the funeral. I will say of Mr. Spafford, that he was a Christian in every act and deed; was loved by all who enjoyed the pleasure of his acquaintance; a friend to all who desired the friendship of a noble man. In every walk of life, he was a true man, a kind father, and a loving husband.

Second: Captain Robert M. Peck died at his home in Pacific, Mo., April 5th, 1897, and was buried at same place on April 7th. Friend Peck's illness was of short duration. He had just returned from a washout on the Iron Mountain road near De Soto, Mo. He had worked in his office on April 4th, ate a hearty breakfast on morning of 5th, after which he complained of not feeling well, and returned to his room and died at 8:45 a. m. Cause of death was attributed to heart trouble. In the death of Captain Peck, we realize the loss of a very valuable and worthy member, who joined our association during the year 1892. He was elected as member of Executive Board in 1894, and served as Chairman of Executive Board during year 1895. Was elected to office of Fourth Vice President at our sixth annual meeting.

Mr. Peck filled the official position of Superintendent of Bridges and Buildings of the Missouri Pacific Railway system for over a quarter of a century. Was a very efficient and capable man in his line. Our association has been benefited much by Mr. Peck's able reports rendered on different matters under discussion.

Third: Friend Abel S. Markley, who met death by accident September 9, 1897, by falling from ladder on water tank at Wildwood, Pennsylvania, while out on a tour of inspection in company with his superintendent. Mr. Markley was enrolled as one of our charter members; has been an active member of our association; was highly esteemed by all who knew him.

I will not dwell further upon the acts and deeds of our deceased friends, as Memorial Committee will take same up in detail, which will be published in our proceedings.

On March 10th, I responded to a call by Chairman of Executive Committee, and attended a meeting in Chicago at Leland Hotel. Meeting was called to order at 9:35 a. m.; W. O. Eggleston in the chair. Members present: W. O. Eggleston, W. M. Noon, George J. Bishop, C. P. Austin, M. Riney, N. W. Thompson, W. S. Danes, and myself. Everything passed off harmoniously. Geo. J. Bishop was appointed a committee of one to make all necessary arrangements for comfort and convenience of members attending our seventh annual meeting to be held at Brown Palace Hotel, Denver, Colorado, October 19th, 20th, and 21st, 1897. The reports from our secretary and treasurer were read, which showed our finances in a very healthy condition.

I desire to say to members of Executive Committee, that I hold in high estimation their hearty support and interest shown by all members being present at meeting, also to friend Austin, who traveled so far to meet with us, and further, I desire to thank our good friend, the Deacon, for the efficient manner in which he has handled the business of our association; always found him prompt, courteous, and reliable in responding to all questions.

I also desire to thank our friend, Mr. George J. Bishop, for the able and efficient manner in which he completed arrangements for comforts of our members attending the convention.

Permit me, in conclusion, to thank *all* the members of this association for the expression of confidence implied by your committing the affairs of this association to me one year ago. I shall always esteem it a great honor to have held the highest official position in your power to bestow. I shall continue to take same interest in the welfare and prosperity of our association as heretofore, and shall always esteem it a great pleasure and benefit to be present and take an active part at all meetings. I can only ask you to please give the same hearty support to my successor in office.

JAMES STANNARD,
President.

President.—The next business in order is the reports of the secretary and treasurer.

REPORT OF SECRETARY.

CONCORD, N. H., October, 1897.

To the Officers and Members of the Association of Railway Superintendents of Bridges and Buildings:

GENTLEMEN: Your secretary submits the following report:

Our sixth annual convention adjourned October 22d, 1896, to meet in Denver, Colorado, October 19, 1897. The executive committee met in Chicago, March 10th, completed the arrangements for our seventh annual convention, and had a very full and successful meeting.

We have 137 names on our membership list at the present time, three having died during the year, Mr. L. K. Spafford of the K. C., F. S. & M. Ry., Kansas City, Mo., R. M. Peck of the M. P. & St. L., I. M. & S. Ry., Pacific, Mo., and Abel S. Markley of the Pittsburg & Western Ry., Allegheny, Pa., all active members, and they will be much missed at our conventions. Twenty new names were added to the list at Chicago, and we have several applicatious to be acted upon at this meeting.

FINANCIAL.

Dr.

Cash on hand, per last report	$328.66	
Cash received from new members . . .	95.00	
Cash received for dues	255.85	
Cash received for advertisements	715.00	
Cash received for sale of proceedings . . .	30.46	
Total		$1,424.97

Cr.

Paid treasurer cash	$350.00	
Expenses for which I hold vouchers . . .	877.38	1,227.38
Balance in hands of secretary,		$197.59

Respectfully submitted,

S. F. PATTERSON,
Secretary.

Mr. Berg.—Mr. President, I would move that the report of the secretary be referred to the Auditing Committee.

Motion was seconded and carried.

Mr. Patterson.—I feel under great obligations to the members for their courteous treatment and their willingness to help me on every occasion. I appreciate this help and wish to thank the members.

To the President and Members of the Association of Railway Superintendents of Bridges and Buildings:

Your treasurer submits the following report:
June 14th, 1897, received from the secretary . . $350.00
All of which is on hand.

N. W. THOMPSON,
Treasurer.

Denver, Colorado, October 19th, 1897.

Mr. Berg.—Mr. President, I move that the report of the treasurer be referred to the Auditing Committee.

Motion seconded and carried.

President.—The next order of business is the appointment of committees. I will appoint the following committees:

List of committees to act during session of seventh annual convention as follows:

NOMINATION OF OFFICERS FOR ENSUING YEAR.

Geo. J. Bishop, W. O. Eggleston, John Foreman.

AUDITING ACCOUNTS.

C. P. Austin, W. B. Yearance, W. E. Harwig.

SUBJECTS FOR DISCUSSION.

C. C. Mallard, W. M. Noon, T. M. Strain, W. O. Eggleston, J. H. Cummin, A. Shane, M. Riney, E. F. Reynolds, John D. Isaacs.

RESOLUTIONS.

Walter G. Berg, N. W. Thompson, M. Riney.

OBITUARY.

J. H. Cummin, W. M. Noon, F. W. Tanner.

MEMOIR.

Walter G. Berg, W. A. McGonagle, W. S. Danes.

President.—Mr. Berg, acting as assistant secretary, will now read a number of letters that the secretary has received.

Mr. Berg then read letters and telegrams from various parties, requesting the association to hold the next convention at Cincinnati, Omaha, and Fortress Monroe, Va.

Further, letters and telegrams from the following members, expressing regrets at their inability to be present, and wishing the association a successful meeting, namely, from: J. H. Markley, Aaron S. Markley, J. O. Olmstead, W. A. McGonagle, and Onward Bates.

President.—The next business in order is the reading of reports of committees on subjects for report selected last year. Subject No. 1, "Methods of Heating Buildings where three or more stoves are now used." Committee,—J. H. Cummin, George W. Hinman, George W. Markley, William Berry.

Mr. J. H. Cummin, chairman, read the report (see report).

President.—Subject No. 2, "The most suitable material for roofs of buildings of all kinds." Committee,—G. W. Turner, W. M. Noon, N. W. Thompson.

Mr. Berg read the report by request of Mr. W. M. Noon, chairman (see report).

President.—Subject No. 3, "Round House Construction, Including Smoke-Jacks and Ventilators." Committee,—George W. Andrews, O. J. Travis, W. O. Eggleston, James T. Carpenter.

Mr. Cummin.—I would state, Mr. President, that about two weeks ago I received a letter from Mr. Andrews, stating that it would be impossible for him to be present at this meeting, and also that he had put off the matter of preparing his report so long that it would be utterly impossible to get the report in shape to present at this meeting. He said if the association desired to continue the committee for another year and allowed him to remain as chairman, he thought that in all probability at that time the committee would be ready to present a report.

Mr. Berg.—I move that the committee be discharged and that the matter of embodying this subject in the list of subjects for next year should be referred to the Committee on Subjects.

Motion seconded and carried.

President.—Subject No. 4, "Care of Iron Bridges after Erection." Committee,—James H. Travis, T. M. Strain, H. M. Hall, Walter A. Rogers.

Mr. Berg.—Mr. President, I understand that the secretary has not received any advice or letters in this matter. I would, therefore, move that, unless some other member has information on the subject, the committee be discharged.

Motion was seconded and carried and the committee discharged.

President.—Subject No. 5, "How to Determine Size and Capacity of Openings for Waterways." Committee,—Walter G. Berg, Aaron S. Markley, Onward Bates, A. J. Kelley.

Mr. Walter G. Berg, chairman, read the report (see report).

President.—Subject No. 6, "Protection of Railroad Buildings and other Structures from Fire." Committee,—W. A. McGonagle, M. M. Garvey, J. D. Hilderbrand, John Foreman.

Mr. Berg.—There is nothing on the secretary's table, and I move that the committee be discharged, but that this subject be referred to the Committee on Subjects for consideration.

Motion seconded and carried.

President.—Subject No. 7, "Designs for Ice-Houses." Committee, W. B. Yereance, C. M. Large, J. H. Markley, George W. Ryan.

Mr. Berg, by request of the chairman, Mr. Yereance, who

was busy with the Auditing Committee, read the report (see report).

President.—Subject No. 8, "Best End Construction for Trestles Adjoining Embankments." Committee,—C. C. Mallard, W. S. Danes, R. L. Heflin, A. C. Olney.

Mr. Mallard.—Mr. President, we would like a little further time, as the members of the committee are not quite ready to report. We wish to hold another conference meeting.

President.—We will grant you more time, Mr. Mallard. We will proceed to subject No. 9, "Bridge Warnings for Low Overhead Structures." Committee,—W. E. Harwig, M. A. Martin, E. H. R. Green, Joseph Doll.

Mr. Harwig.—I am engaged with the Auditing Committee, would request to have the reading postponed.

President.—Subject No. 10, "Stock-yards and Stock-sheds, Including all Details of Construction." Committee,—George J. Bishop, W. R. Cannon, O. H. Andrews, James Brady.

Mr. George J. Bishop, chairman, read the report (see report).

President.—Subject No. 11, "Floor Systems on Bridges, Including Skew Bridges." Committee,—B. W. Guppy, C. P. Austin, C. W. Gooch, F. W. Tanner.

Owing to the absence of Mr. Guppy, chairman, the report was read by Mr. F. W. Tanner (see report).

Mr. Berg.—Mr. President, a request has been received from Mr. A. Zimmerman to be reinstated upon payment of back dues of twenty-two dollars, which he has paid. Mr. Zimmerman was one of our charter members, and was carried on our rolls several years. He was formerly with the Missouri Pacific Railway, and is now with the Union Pacific, Denver & Gulf. I move that he be reinstated.

Motion was seconded and carried.

President.—Mr. Zimmerman having paid his dues is reinstated.

Mr. Bishop, as chairman of the Local Committee of Arrangements, by request of the president, made announcements as to a special trip from Denver to Colorado Springs, Pike's Peak, and other matters relating to arrangements made by the Local Committee.

Mr. Mallard announced that the Committee on Subjects would meet at nine o'clock Wednesday morning and requested any member to be present who had any subject for discussion he desired to bring to the attention of the committee.

President.—The meeting will now adjourn until 2 p. m.

AFTERNOON SESSION, TUESDAY, OCTOBER 19, 1897.

Meeting called to order at 2 p. m.

President.—Mr. Mallard, is the committee ready to report on subject No. 8, "Best End Construction of Trestles Adjoining Embankments?"

Mr. Mallard, chairman, read the report (see report).

President.—Mr. Harwig, will you read the report on subject No. 9, "Bridge Warnings for Low Overhead Structures?"

Mr. Harwig, chairman, read the report (see report).

President.—Are there any committee reports to be read?

Mr. Berg.—Mr. President, the Nominating Committee has handed in the following report:

REPORT OF COMMITTEE ON NOMINATIONS FOR OFFICERS.

Mr. President, Officers, and Members of the Association of Railway Superintendents of Bridges and Buildings:

Your Committee on Nominations begs leave to submit the following as officers of this association for the year 1897–'98:

President—Walter G. Berg, Lehigh Valley R. R.

First Vice-President—Joseph H. Cummin, Long Island R. R.

Second Vice-President — Aaron S. Markley, Chicago & Eastern Ill. R. R.

Third Vice-President—G. W. Hinman, Louisville & Nashville R. R.

Fourth Vice-President—C. C. Mallard, Southern Pacific R. R.

Secretary—Samuel F. Patterson, Boston & Maine R. R.

Treasurer—N. W. Thompson, Pittsburgh, Ft. Wayne & Chicago R. R.

Executive Committee—Geo. J. Bishop, Chicago. Rock Island & Pacific R. R.; C. P. Austin, Boston & Maine R. R.; M. Riney, Chicago & Northwestern R. R.; Wm. S. Danes, Wabash R. R.; J. H. Markley, Toledo, Peoria & Western R. R.; W. O. Eggleston, Chicago & Erie R. R.

Respectfully submitted,

Geo. J. Bishop,
W. O. Eggleston,
John Foreman.

President.—What action do you wish to take on the report of the Nominating Committee?

Motion that the report be received and the committee discharged was duly seconded and carried.

President.—Unfinished business is the next order of business.

Mr. Berg.—Mr. President, under the head of unfinished business, a constitutional amendment announced at the last meeting, I think, would be proper to have brought up now. The proposed amendment is printed on page twenty of our last proceedings, and refers to Section 1, Article IV, of the Constitution.

President.—What action do you wish to take in this matter?

Mr. Cummin.—I would like to offer an amendment to that amendment, namely:

At the end of Section 1, Article IV, of the Constitution, add the following words,—"All Past-Presidents of this association, who continue to be members, shall be entitled to be present at all meetings of the Executive Committee, of which meetings they shall receive due notice, and be permitted to discuss all questions coming before the Executive Committee and to aid said committee by their advice and counsel; but, said Past-Presidents shall not have a right to vote, nor shall their presence be requisite in order to constitute a quorum."

My object in offering this amendment is to have the regular members of the Executive Committee, who are elected by the association, feel that the responsibility of that committee rests upon them. While I think it is wise to have the advice and counsel of the past-presidents of the association, it might, and in fact would, in a few years be possible for the past-presidents of the association to control that committee, and the Executive Committee would be a mere figure head in one sense of the word. By having the advice and counsel of the past-presidents of the association, the committee members can then use their own judgment as to whether they will act up to it, as they only, as the committee, are entitled to vote and it does not deprive them of any of their prerogatives.

Mr. Berg.—Mr. President, as the original mover of the amendment to which Mr. Cummin's amendment refers, I would

like to withdraw my amendment with the consent of my seconder, Mr. Patterson, and adopt Mr. Cummin's amendment as the original amendment.

President.—You have heard the amendment to our constitution; are there any remarks from any of the members?

Amendment was unanimously carried.

President.—The next unfinished business will be the discussion of the reports presented last year. Subject, "Different Methods of Numbering Bridges. Should all Waterways Be Numbered?"

See discussion of this subject, participated in by A. Shane, Walter G. Berg, C. C. Mallard, W. E. Harwig, N. W. Thompson, W. M. Noon, B. F. Bond, James McIntyre, T. M. Strain, Wm. Carmichael, A. J. Kelley, F. W. Tanner, A. Zimmerman, F. Eilers, John D. Isaacs, George E. Hanks, J. B. Sheldon, H. W. Fletcher, W. O. Eggleston, J. M. Staten, C. W. Vandergrift, C. P. Austin, W. Z. Taylor, and A. McNab.

President.—The next subject is, "Drawbridge Ends, Methods of Locking; and Under This Head Include Locking of Turn-tables."

See discussion of this subject, participated in by Walter G. Berg, C. P. Austin, C. C. Mallard, F. W. Tanner, W. O. Eggleston, and F. Eilers.

President.—The next subject is, "Protection of Trestles from Fire, Including Methods of Construction." Is there anything further on this subject? If not, it is closed, and we will proceed to the next subject, "Local Stations for Small Towns and Villages, Giving Plans of Buildings and Platforms."

See discussion of this subject, participated in by J. H. Cummin and Walter G. Berg.

President.—The next subject is, "Tanks, Size, Style, and Details of Construction, Including Frost-proof Protection to Tank and Pipes."

See discussion of this subject, participated in by W. O. Eggleston, C. C. Mallard, A. Shane, F. W. Tanner, W. M. Noon, A. McNab, John D. Isaacs, James Stannard, and B. F. Bond.

President.—The next subject is, "Best and Uniform System of Report Blanks for Bridge and Building Department."

See discussion of this subject, participated in by F. W. Tanner and A. Shane.

President.—The next subject is, "Mechanical Action and Resultant Effects of Motive Power at High Speed on Bridges." If there are no remarks, we will proceed to the subject, "Best and Most Economical Railway Track Pile-driver."

See discussion of this subject, by John D. Isaacs.

President. If there are no other remarks, we will proceed to the next subject, "Span Limits for Different Classes of Iron Bridges, and Comparative Merits of Plate-Girders and Lattice Bridges for Spans from 50 to 110 Feet." If there are no remarks, the discussion of last year's subjects will now be considered closed. We will hear any reports that the secretary has received.

Mr. Berg.—The following report has been received from the Auditing Committee.

REPORT OF AUDITING COMMITTEE.

Denver, Col., October 19, 1897.

To the Members of the Association of Railway Superintendents of Bridges and Buildings:

The Auditing Committee, for the year 1897, reports as follows, on the account submitted by the secretary:

Dr.

Balance in hand October 1, 1896	$328.66	
Dues received for the year 1896–7	350.85	
Received for advertising in proceedings of year 1896	715.00	
Received from sale of reports of the year 1896	30.46	
		$1,424.97

Cr.

Expenses represented by checked vouchers	$877.38	
Remittance to the treasurer of June 14, 1897	350.00	
		1,227.38
Balance in hands of the secretary		$197.59

Respectfully submitted,

C. P. Austin,
W. B. Yereance,
W. E. Harwig.

President.—What will you do with the report of the Auditing Committee as read?

Mr. Shane.—I move that it be received and incorporated in our proceedings.

Motion was seconded and carried.

Mr. Berg.—Mr. President, the Committee on Memoirs has the following report to present:

REPORT OF COMMITTEE ON MEMOIRS.

Your Committee on Memoirs respectfully present memoirs of our deceased members: H. Dunlap, W. S. Tozzer, L. K. Spafford, J. B. Mitchell, R. M. Peck, George M. Reid, and Abel S. Markley.

During the year a circular was sent out requesting information and data relative to our deceased members, and some data has been collected for utilization in the preparation of several additional memoirs, but we regret that such data is not sufficient to allow memoirs to be completed.

We earnestly request all members to endeavor to collect data relative to the lives of our deceased members, and forward such information to the new Committee on Memoirs to be appointed at this meeting so that this important work can be completed, reflecting credit on our association and serving as a tribute to our deceased members by making a record of their life's work and professional achievements in our proceedings.

Memoirs of the following deceased members have still to be prepared: James DeMars, C. E. Fuller, L. S. Isdell, J. J. Troutman, and T. B. Graham.

Respectfully,

WALTER G. BERG,
W. S. DANES,
Committee.

President.—If there are no objections, the report will be received and the memoirs will be printed in our proceedings.

President.—Mr. Secretary, have you anything to bring up?

Mr. Patterson.—No, sir, I have not.

President.—Are there any notices to be given to the committees about meetings to-morrow?

Mr. Mallard.—I would like to have any subjects for reports for next year that any member may wish brought up handed in to me, and to have members attend the meeting of the Committee on Subjects to-morrow morning.

Mr. Berg.—Mr. President, if there is nothing else before the meeting, I move that the meeting be now adjourned until ten o'clock to-morrow morning.

Motion seconded and carried.

Meeting adjourned until 10 a. m., Wednesday, October 20th, 1897.

SECOND DAY, WEDNESDAY, OCTOBER 20, 1897, MORNING SESSION.

Convention called to order at 10 o'clock.

President.—We will proceed with reports of committees. I would like to hear from the Obituary Committee. While the report is read members will please arise. I will request Mr. J. H. Cummin, chairman, to read the report.

REPORT OF OBITUARY COMMITTEE.

WHEREAS, We are again reminded in the most forcible manner that our earthly existence is but transitory. God in his infinite wisdom has been pleased to sever our fraternal ties and call from earthly scenes and labors our associates, L. K. Spafford, R. M. Peck, and Abel S. Markley, whose cheerful faces and cordial greetings were so familiar at our meetings. Therefore, be it

Resolved, That in appreciation of their many excellent qualities and valuable services as members of this association, we place upon record our fraternal tribute of respect and sorrow at this severance of social ties.

Resolved, That we tender our warmest sympathy to the families of our deceased friends in their sad bereavement, well knowing that we cannot so fully appreciate their many sterling qualities as those who have formed a part of their household and felt the influence of their daily companionship.

Resolved, That these resolutions be entered upon our minutes, and a copy thereof transmitted to the families of our deceased associates.

J. H. CUMMIN,
W. M. NOON,
F. W. TANNER,
Committee.

President.—We will now take up the discussion of committee reports submitted at this convention. The first subject is, "Methods of Heating Buildings where Three or More Stoves are Now Used." Mr. J. H. Cummin is chairman of that committee.

See discussion of this subject, participated in by J. H. Cummin, A. Shane, John D. Isaacs, C. C. Mallard, W. B. Yereance, J. B. Sheldon, W. S. Danes, J. B. Pullen, W. E. Harwig, G. J. Bishop, G. E. Hanks, F. Eilers, A. Montzheimer, N. W. Thompson, James Stannard, and C. P. Austin.

President.—If there are no further remarks, we will pass to the next subject, "The Most Suitable Materials for Roofs of Buildings of All Kinds." Mr. W. M. Noon acted as chairman of the committee.

See discussion of this subject, participated in by J. H. Cummin, John D. Isaacs, A. Shane, N. W. Thompson, J. B. Sheldon, S. F. Patterson, G. E. Hanks, G. J. Bishop, W. B. Yereance, W. O. Eggleston, T. M. Strain, F. Eilers, W. E. Harwig, J. M. Staten, C. C. Mallard, O. H. Andrews, John Foreman, A. J. Kelley, C. W. Vandergrift, Walter G. Berg, E. F. Reynolds, W. S. Danes, A. H. King, F. W. Tanner, and A. Zimmerman.

President.—The next subject is "Round-House Construction, Including Smoke-Jacks and Ventilators." This subject will be one of the subjects for next year. If there are no remarks we will pass this subject and proceed to the discussion of the next subject, "Care of Iron Bridges Afte Erection."

See discussion of this subject, participated in by T. M. Strain and F. Eilers.

Mr. Mallard.—I move that this subject be included in the list of subjects for the next meeting.

Motion seconded and carried.

President.—We will now take up the subject, "How to Determine Size and Capacity of Openings for Waterways."

The chairman, Mr. Walter G. Berg, made some general remarks in regard to the report.

President.—We will now take up the subject, "Protection of Railroad Buildings and Other Structures from Fire." There was no report on this subject.

Mr. Berg.—Mr. President, I have some valuable papers that I would like to present and leave it to be decided by the proper parties whether to embody them in our proceedings; a letter from Mr. E. F. Brooks, Superintendent of the Pennsylvania Railroad Company at Jersey City, giving concisely all their methods for protection from fire at the Jersey City passenger terminal and all their freight terminals and important structures.

Mr. Mallard.—I believe that is one of our subjects for next year, and if Mr. Berg will turn those papers over to the committee they will be glad to make use of them.

Mr. Berg.—In consideration of that being one of the subjects for next year, I move that the matter be dropped at this time.

Motion was seconded and carried.

Mr. Mallard moved to adjourn. Motion seconded and carried.

Meeting adjourned until two o'clock.

AFTERNOON SESSION, WEDNESDAY, OCTOBER 20, 1897.

Meeting called to order at 2 o'clock.

President.—Mr. Bishop, have you any announcements to make?

Mr. Bishop explained the arrangements for a trip the following morning to the Boston Smelter.

President.—Mr. Yereance, the discussion of your committee report on "Designs for Ice-houses," is in order.

See discussion of this subject, participated in by W. B. Yereance, G. J. Bishop, James Stannard, W. Carmichael, John D. Isaacs, J. B. Sheldon, Walter G. Berg, F. W. Tanner, A. H. King, G. E. Hanks, F. Eilers, Charles F. Pierce, J. H. Cummin, J. M. Staten, and A. Montzheimer.

President.—The next subject is "Best End Construction for Trestles Adjoining Embankments." Mr. Mallard is the chairman of that committee.

See discussion of this subject, participated in by C. C. Mallard, T. M. Strain, W. Carmichael, A. McNab, G. J. Bishop, M. Riney, A. Shane, J. M. Staten, A. Zimmerman, and W. O. Eggleston.

President.—The next subject is "Bridge Warnings for Low Overhead Structures."

See discussion of this subject, participated in by Walter G. Berg, J. H. Cummin, D. K. Colburn, J. M. Staten, S. F. Patterson, G. E. Hanks, A. J. Kelley, J. B. Pullen, A. Shane, F. Eilers, J. B. Sheldon, F. W. Tanner, and C. C. Mallard.

President.—We will take up "Stock Yards and Stock Sheds, Including all Details of Construction."

See discussion of this subject, participated in by John D. Isaacs, W. Carmichael, and A. W. Merrick.

President.—We will pass to the next subject, "Floor Sys-

tem on Bridges, Including Skew Bridges." Mr. W. B. Guppy, the chairman of this committee, is not present.

Mr. Berg.—Mr. President, the secretary has on his table written discussions on bridge floors, forwarded by our members, J. P. Snow and John Foreman. Also a written discussion kindly contributed by Mr. J. R. Worcester, Civil Engineer of Boston, Mass. I would recommend that these discussions be embodied in our proceedings.

President.—If there are no objections, they will take this course, and be inserted in our proceedings. If there are no further remarks on this subject, we will close the discussion of this year's reports. The next order of business is "Reading and Discussion of Questions Propounded by Members." I understand Mr. Bishop desires to make some remarks on the subject of pile hammer rope.

See remarks of G. J. Bishop on "Pile Hammer Rope," and discussion by Walter G. Berg, Wm. Carmichael, F. Eilers, G. J. Bishop, and W. A. Rogers.

President.—I further understand that Mr. Shane desires to speak on the subject of "Gas Engines For Pumping Water."

See remarks of A. Shane on "Gas Engines For Pumping Water."

President.—We will now proceed to Miscellaneous Business.

Mr. Cummin.—Mr. President, I have a resolution I would like to read to this association.

Resolved, That it is the sense of this association that during the coming year the executive committee should issue a circular to the superintendents of bridges and buildings of the different railroads of the country explaining the benefits derived by membership in this association, and giving them a cordial invitation to join us, and thus participate with us in the benefits derived, and help to extend the representative character of this association, thereby enlarging its sphere of usefulness.

My object in offering this resolution is this: I believe that there are a large number of superintendents of bridges and buildings connected with the different railroads of the country, who have no idea of the benefits derived from membership in this association; they have no idea of our work. While our secretary in the past has once in a while sent out applications

to different men in different sections of the country, still, I do not believe the matter has been gone into systematically. It seems to me, if our executive committee, composed as it is for the ensuing year, will get up a circular and send it out broadcast over the country to these different men, I think we will see in another year a grand result arising from that circular that will not only benefit us, but also the new members. Of course this should all be done without lowering the dignity of our association or the standing of the membership.

Mr. Berg.—Mr. President, I desire to second that motion of Mr. Cummin's. I believe it will be a good thing.

Motion was unanimously-carried.

President.—The next in order is the report from the Committee on Subjects for next year.

Mr. Mallard, chairman, then read report of Committee on Subjects for next year as follows:

REPORT OF COMMITTEE ON SUBJECTS FOR 1898.

1. Pile-rings and method of protecting pileheads in driving.
2. Cost and manner of putting in pipe culverts.
3. Best floors for shops and roundhouses.
4. Roundhouse smokejacks and ventilation.
5. Cattleguards and wingfences.
6. Prevention of fire in railroad buildings.
7. Storage of fuel, oil and other station supplies at way stations.
8. Railroad highway crossing gates.
9. What repairs, and how can they be safely made, to metal and wooden spans without the use of falsework.
10. Care of iron bridges after erection, including best method of protecting them from injury by salt water drippings from refrigerator cars.
11. Turntable construction.

Respectfully submitted,

C. C. Mallard,
W. M. Noon,
W. O. Eggleston,
J. H. Cummin,
A. Shane,
M. Riney,
E. F. Reynolds,
John D. Isaacs,
T. M. Strain.

Mr. Berg.—Mr. President, I move that the report be accepted.

Motion was seconded and carried.

President.—If there is any other member that wishes to introduce a subject, we would be glad to report on it and add it to the list.

Mr. Berg.—Mr. President, unless there is any further business, I move that we adjourn until to-morrow afternoon at two o'clock.

Motion was seconded and carried.

Meeting adjourned to two p. m., Thursday, October 21, 1897.

AFTERNOON SESSION, THURSDAY, OCTOBER 21, 1897.

Meeting called to order at two p. m.

President.—Mr. George J. Bishop, will you please step this way? Mr. Cummin will make some remarks.

Mr. Cummin.—Brother Bishop: Although this is not, in a strict sense of the term, a fraternal organization, still I know that in your case, I have the right to use the fraternal term of brother.

There are certain times in our lives when we are called upon to perform duties for which we feel ourselves entirely incompetent. Such is the position in which I find myself placed to-day. I have been requested by the president to perform a duty, which, while I feel it to be one of the most pleasant of my life, I know could have been done in a far better manner by some of the other members. Our association is, in some respects, a peculiar one; in a religious way we are well provided for with a "Bishop" and a "Deacon"; in the matter of fruit, there is always an "Apple" and several "Berrys," which we can use either "White" or "Green." Should something more substantial be required, we can easily "Fry" a "Large" "Mallard," which would be fit for a "King" at high "Noon."

We have a "Foreman" "Carpenter," who is able to take a "Short" "Strain" on the "Bond" that binds "Midwinter" and "Snow" together, while if at any time our discussion becomes too warm, we have a "Wise" "Berg" to cool us off, so that "Mc" will have no occasion to "Nab" us when we go "Nutting."

But seriously speaking, my brother, from the time the circular was sent out by the Executive Committee, announcing this meeting, together with the excursions that had been planned, for the enjoyment of the members, by yourself, as the representative of that committee, the members of this association have felt that they were under the deepest obligation to you for the warm interest you have taken in their behalf, and they have asked me to tender to you, in their name, a slight token of their esteem and regard. They ask you to accept it, not in any sense on account of its intrinsic value, but with their warmest wishes for your future success and welfare. I, therefore, present this silver tea service to you in behalf of the officers and members of our association, and sincerely trust that, whenever yourself and good wife shall have occasion to use it, it will bring up pleasant memories of the reunion we had at this time in the beautiful city of Denver.

Mr. Bishop.—Mr. President and members of the Association of Superintendents of Bridges and Buildings, this is a complete surprise and entirely unexpected by me. I cannot express my feelings and the gratitude I feel. I thank you sincerely.

Mr. Berg.—Mr. President, I desire to emphasize the pleasure it has been to all of us to show Mr. Bishop our appreciation of his work as the Local Committee, and to assure him that it was a spontaneous feeling and idea that seemed to be unanimous and that prompted all members to desire the presentation of this testimony of our regard to Mr. Bishop. His energy and interest in making all the arrangements for our meeting here have been exceptional. He might have done his duty; he has not only done his whole duty, but more than his whole duty.

President.—We will take a recess to allow members to greet Mr. Bishop.

After the recess the order of miscellaneous business was continued.

Mr. Berg.—Mr. President, the Committee on Resolutions has the following report to offer:

REPORT OF COMMITTEE ON RESOLUTIONS.

Resolved, That the thanks of this association be tendered to Mr. W. A. Deuel, general superintendent, Union Pacific Railway, Denver, Col.; to Mr. C. H. Schlacks, assistant general manager, Denver and Rio Grande Railway, Denver, Col.; to Mr. G. W. Ristine, receiver and general manager, Colorado Midland Railway, Denver, Col.; to Mr. C. W. Sells, manager, Manitou and Pike's Peak Cog Railway, Manitou, Col.; to Mr. L. F. Kimball, first assistant general freight agent, Chicago, Rock Island and Pacific Railway, Denver, Col.; to Mr. W. H. Firth, general agent, passenger department, Chicago, Rock Island and Pacific Railway, Denver, Col.; to Mr. J. J. Frey, general manager, Atchison, Topeka and Santa Fe Railway, Topeka, Kan.; to T. F. Dunaway, general superintendent, Union Pacific, Denver & Gulf Railway; to the Pullman Palace Car Company; and to the Wagner Palace Car Company for special transportation facilities granted to the association.

Resolved, That the thanks of this association be tendered to Mr. R. Pearse, general manager of the Boston and Argo Smelter at Denver, Col.; to the Sherwin-Williams Company; and to Mr. N. M. Tabor of the Brown Palace Hotel Company at Denver, Col., for courtesies extended the members of the association during their stay in Denver.

Resolved, That this association desires to acknowledge its appreciation of the attendance at the convention of special representatives of the *Railway Review* and of the *Railroad Gazette*.

Resolved, That the special thanks of this association be tendered to Mr. Geo. J. Bishop, to whose efficient and untiring work as the Local Committee appointed for making preparations for this meeting, in connection with the assistance of our president, Mr. James Stannard, the success of the meeting is largely due, and that we trust that his exceptional work and energy in the matter may prove an incentive to members entrusted with the same duties at future conventions.

Resolved, That this association desires to thank all its officers for their efficient conduct of the business of this association during the past year and the present convention, and further to express its appreciation of the worthy conduct of this convention by our president, Mr. James Stannard, and of the work of our secretary, and of the members appointed on the various committees.

Resolved, That this association desires to express its appreciation and thanks to all non-members of the association who have rendered valuable assistance to the various committees in the preparation of their reports; and that the secretary be directed to transmit these resolutions, together with a complimentary copy of the printed proceedings, to all such parties as specified by the chairmen of the several committees.

WALTER G. BERG,
N. W. THOMPSON,
M. RINEY,
Committee.

President.—What action do you wish to take on the report?

Motion was made, seconded, and carried that the report of the Committee on Resolutions be adopted as read.

Mr. Berg.—Mr. President, I offer the following motion:

"The Executive Committee is instructed to omit from the

published proceedings of this convention any matter which is directly in the nature of a special advertisement."

Motion was seconded and carried.

President.—Under the head of miscellaneous business we select our next place of meeting. I will appoint Mr. Yereance and Mr. Mallard as tellers.

Mr. Mallard.—I nominate Richmond, Va., for the next place of meeting.

Mr. Isaacs.—I second the motion.

Mr. Shane.—I move that it be Washington, D. C.

Mr. N. W. Thompson.—I nominate Chattanooga, Tenn.

Mr. Mallard.—I would like to say in answer to Mr. Thompson's nomination of Chattanooga that in case the yellow fever was prevalent, it would be impossible to go to Chattanooga.

Mr. Thompson.—I withdraw my nomination on that account.

Mr. Kelley.—I nominate Milwaukee, Wis.

The nominations were on motion duly closed, and on a ballot being taken, 39 votes were cast, divided as follows: Richmond, 21; Washington, 14; Milwaukee, 3; Omaha, 1. Richmond, Va., was selected for the next place of meeting and so declared by the president.

President.—Is there anything further to offer in the way of miscellaneous business? If not, the next order of business is the election of officers for the ensuing year. Mr. Berg, will you read the list of officers as recommended by the Nominating Committee.

Mr. Bond.—Mr. President, I move that the recommendations of the committee be received and the secretary cast the vote.

Motion was seconded and carried.

Mr. Patterson.—The vote is cast, and the names as read by the assistant secretary have the desired vote.

President.—I declare the officers unanimously elected as the vote was cast, namely:

President—Walter G. Berg.
First Vice-president—Joseph H. Cummin.
Second Vice-president—Aaron S. Markley.
Third Vice-president—G. W. Hinman.
Fourth Vice-president—C. C. Mallard.

Secretary—Samuel F. Patterson.
Treasurer—N. W. Thompson.
Executive Committee—George J. Bishop, C. P. Austin, M. Riney, Wm. S. Danes, J. H. Markley, W. O. Eggleston.

President.—Unless there are further matters to take up, we will now proceed to the installation of officers.

President.—Mr. Berg, you have been elected by this association as president for the ensuing year, and I am pleased to have the opportunity of welcoming you as president of our association. It is not necessary for me to attempt to make any speech on this occasion, as all the members are acquainted with you and know your ability. The papers of this office. you have received, and lastly I now present you with the gavel. You now enter upon the duties of your office.

Mr. Berg.—Mr. Stannard, I desire to thank you for the kind and courteous words expressed in my behalf, and assure you that it will be my endeavor to be a worthy successor to you in the association. To all the members I offer my thanks for this honor, and promise you that I will continue to work as my ability permits and as faithfully as I have endeavored to do in the past. But, gentlemen, it is not the work of your president that tells alone. Much depends on your president, more on your secretary, and most of all on the members themselves; not only those who are entrusted with committee work, but all the members in various ways, and all should show their interest and enthusiasm for the association and the matters we are all working to accomplish. It is a very little task for a member individually to pay attention to the request of a committee for information and to endeavor to give some. The busy man has time to attend to business, is an old adage. Further, members should in every way advance the interests of the association by spreading the knowledge of the work we are doing, and especially of our aim to raise the standard of the association to one of importance in the railroad technical world.

There are a few leading principles in connection with the association that I am a staunch believer in, and perhaps it might be well for me to explain and emphasize my position on such matters.

I consider that one of the vital points for us to attend to, is

to preserve our independence, and see that we are not controlled by outside interests or auxiliary organizations.

Further, that business should always precede pleasure, taking pleasure when we can, but attending to the important work that we come together for, namely, business.

An additional feature that we should observe, so that we will not strand on the rocks that have damaged somewhat similar associations in the past, is, that we should keep our association free from any suspicion that the official power and weight that accompany transactions before this body will be used for advertising purposes.

Gentlemen, my aim is, and I hope it is that of every member, to raise the standard of the association. We have passed our infancy; we are seven years old; and I trust that when we come to celebrate our tenth anniversary that we will not only feel but know that we are entitled to rank with the large national and technical associations of this country.

With this short exposition of my views and principles which will guide me in conducting the business of the association, and thanking you again for the honor conferred upon me, and trusting to have the full support of all the members as well as the various officers that you have elected to serve with me, I now assume the presidency of this association for the coming year.

Mr. Cummin, you have been elected first vice-president of this association; do you accept?

Mr. Cummin.—I do, with thanks for the honor conferred upon me.

President.—Mr. Aaron S. Markley and Mr. Hinman, who have been elected vice-presidents, are not present, but I have no doubt from the interest they have shown in the past that they will accept. Mr. Mallard, you have been elected fourth vice-president, will you accept?

Mr. Mallard.—I do, and thank the members for the honor conferred, and will do my best.

President.—Mr. Patterson, you have been elected secretary, do you accept?

Mr. Patterson.—I do.

President.—Mr. Thompson, you have been elected treasurer, do you accept?

Mr. Thompson.—I do, and thank you and the members sincerely.

President.—Messrs. Danes and Eggleston, you have been elected on the Executive Committee, and I assume you will accept. Mr. J. H. Markley is not present, but I have no doubt of his acceptance. Messrs. Bishop, Austin, and Riney hold over from last year. Mr. Bishop will be the chairman of the Executive Committee. I now declare this order of business closed. Mr. Secretary, have you anything to bring up?

Mr. Patterson.—No, sir, unless there are some committees to be appointed.

President.—I will appoint the various committees after I have had time to consider them, and members will receive due notice. Has any member anything further to bring before the meeting. If not, a motion to adjourn would be in order.

Mr. Stannard.—I move that this convention adjourn to meet in Richmond, Va., on the third Tuesday in next October.

President.—You have heard the motion, duly seconded, that this convention adjourn to meet on the third Tuesday in October next at Richmond, Va.

Motion was carried and the convention was declared permanently adjourned accordingly.

The committee appointments for 1897–'98 appear at the head of these proceedings.

The memoirs of deceased members are appended hereto.

The reports and discussions on technical subjects appear separately below.

The next convention will be held in Richmond, Va., on Tuesday, October 18, 1898.

S. F. Patterson,
Secretary.

MEMOIRS OF DECEASED MEMBERS.

MEMOIR.*

HARVEY DUNLAP.

CHARTER MEMBER, . . . SEPTEMBER 25, 1891.
DIED, ... JULY 3, 1892.

Mr. Harvey Dunlap was born in Rondout, Ulster county, New York, in 1852, and died at the age of forty years, on July 3, 1892. He was killed in the performance of his duties in a washout on the Wabash railway, at Kentner Creek, near Wabash, Ind.

He commenced at bridge work with the Ulster & Delaware railroad in 1870, came to Logansport, Ind., with Mr. Frank Hecker, and worked in the coach shops of the Eel River Railroad company until June 1, 1879, when he was appointed foreman of bridges for the Eel River company. From that time he was employed on the Eel River & Wabash railroad as foreman of bridge carpenters to September 12, 1884; general foreman of bridge department between Danville, Ill., and Cairo, to June 1, 1885; foreman of bridge carpenters between Logansport and Detroit, to June 12, 1887; general foreman of bridge department for Wabash Western on same territory, to February 1, 1889; foreman to February 1, 1890; superintendent of bridges and buildings, Wabash railway, with headquarters at Andrews, Ind., to the time of his death, July 3, 1892.

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Mr. Dunlap was a charter member of the association, having joined at the first convention, held at St. Louis, Mo., on September 25, 1891. He died before the next annual convention was held. On October 18, 1892, the committee on obituary reported suitable resolutions with reference to Mr. Dunlap's decease.

* Memoir prepared by Mr. W. S. Danes.

MEMOIR.*

WILLIAM STEVENS TOZZER.

ELECTED MEMBER, ... OCTOBER 19, 1892.
DIED, ... AUGUST 15, 1893.

Mr. Wm. S. Tozzer was born at Salem, Mass., November 23, 1833, and died at the age of fifty-nine years at Cumminsville, Cincinnati, O., August 15, 1893. At a very early age he came from his birthplace to Cincinnati, where he remained until his death. He attended the schools of Cincinnati, especially Woodward High school. At the age of twenty-five he was married to Miss Susan E. Lakeman, with whom he lived for thirty-five years, until his death in 1893.

After receiving his education he spent the remainder of his life in railroad circles, holding a position as superintendent of bridges on the Cincinnati, Hamilton & Dayton railroad for twenty-five years, remaining there until five years before his death, when he entered the employ of the Chesapeake & Ohio railroad as superintendent of bridges.

He was a member of good standing in the Hoffner Lodge, F. & A. M., and Hauselmann Commandery, Knights Templar, for a number of years.

Through his entire life he was a man of noble character and integrity, winning the respect of all associated with him.

He was a sufferer from stomach trouble for about ten years, but it did not seem to interfere with his daily duties until a short time before his death.

He died, leaving a widow and six children, as follows: Charlie A. Tozzer, Mrs. S. D. Wray, Misses Alice, Edith, Grace, and Eunice. His burial took place from the Northside Presbyterian church, Cumminsville, Cincinnati, after which the remains were interred in Spring Grove cemetery.

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Mr. Tozzer was elected a member of the association on October 19, 1892, at the second annual convention, at Cincinnati, O., which meeting was the only one he attended, as his death occurred before the next convention. On October 17, 1893, the committee on obituary reported suitable resolutions with reference to Mr. Tozzer's decease.

* Memoir prepared by a relative of Mr. Tozzer.

MEMOIR.*

J. B. MITCHELL.

CHARTER MEMBER, . . .	SEPTEMBER 25, 1891.
SECOND VICE-PRESIDENT, ...	1891–'92.
DIED, ...	DECEMBER 13, 1894.

J. B. Mitchell was born in Scotland, and died of typhoid fever, on December 13, 1894, aged 63 years, 8 months, and 1 day.

Mr. Mitchell was superintendent of bridges and buildings, Eastern division, Wabash railroad, until February 1, 1890, when he was appointed to the responsible position of superintendent of bridges and buildings, Cleveland, Cincinnati, Chicago & St. Louis railway, with headquarters at Indianapolis, Ind.

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Mr. Mitchell was a charter member of the association, having joined at the first convention, held at St. Louis, Mo., on September 25, 1891. He was present at this convention, taking part in its work and the organization of the association, and was elected second vice-president, serving for one year in that capacity. Mr. Mitchell was present at the second convention, held at Cincinnati, O., October, 1892, serving on the committee on obituary, and he also presented a valuable report on "Pit and Surface Guards," as a member of the committee appointed to report on that subject. Mr. Mitchell was unable to attend the third convention, held at Philadelphia, Pa., but was one of a committee presenting a report on "Crawling of Rails and Its Effects on Structures." At the fourth convention, at Kansas City, Mo., in October, 1894, a letter was received from Mr. Mitchell, in which he asked to be retired from membership, owing to the state of his health, which request was granted.

MEMOIR.†

GEORGE M. REID.

CHARTER MEMBER, . . .	SEPTEMBER 25, 1891.
TREASURER, ...	1891–'96.
MEMBER EXECUTIVE COMMITTEE, . . .	1891–'96.
DIED, ...	FEBRUARY 10, 1896.

George M. Reid was born at Canandaigua, N. Y., March 9, 1832.

His father, Robert Reid, died about two years later, and his mother came to Ohio and settled in Monroe township, Ashtabula county, when he was quite young. After getting a common school education, he

* Memoir prepared by Mr. W. S. Danes.

† Memoir prepared by Mr. R. H. Reid of Adrian, Mich., son of George M. Reid.

worked on the farm for a time, but later went on the lakes as a sailor on the schooner *Stand Back*, his mother, with whom he still lived, moving to Conneaut, in the same county. This was about 1848.

In 1853, he commenced bridge work on the Howe Truss at Girard, Pa., on the C. & E. railroad, under a foreman by the name of Woodworth. He worked on the Painesville bridge in 1855, and in 1856 entered the service of Thatcher, Burt & Co., bridge builders and contractors, continuing in their service until the retirement of Mr. Burt, when the firm changed to McNairy, Claflen & Company. He remained with them as foreman of bridges until May, 1872, when he was appointed bridge inspector on the Lake Shore & Michigan Southern railway, and later superintendent of bridges, which position he held until the time of his death, February 10, 1896.

He was on the train that went down with the Ashtabula bridge, December 29, 1876, and was slightly injured and burned some, but managed to assist in extricating others from the wreck.

He married Miss Sarah E. Corey of Cleveland on December 30, 1863, and moved to Cleveland from Conneaut in March, 1865, where he lived until his death. The family consisted of four children,—Robert, Charles, Della, and Jessie. Robert was born February 8, 1865, at Conneaut, O.; Charles was born January 21, 1867, at Cleveland; Della was born April 4, 1870, and Jessie on December 19, 1873, both at Cleveland.

His death was caused by apoplexy, though he had not been well for a year prior to that.

He was a member of the Knights of Honor, and a third degree Mason, at the time of his death, and had previously belonged to the I. O. O. F., I. O. F., and Royal Arcanum.

He had a strong personality, yet was genial and friendly with all, and enjoyed the friendship of all who knew him, and had the confidence of his superior officers. His life is an instance of what can be accomplished by a struggling farmer boy, with a widowed mother to support, and only a common school education, when he has the right kind of energy and perseverance.

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Mr. Reid was a charter member of the association, having joined at the first convention, held at St. Louis, Mo., on September 25, 1891. In fact, he was one of the organizers of the association and took active part in the business proceedings of the St. Louis meeting. He was elected to the honorable and responsible position of treasurer of the association at the first convention, and was unanimously reëlected at four subsequent conventions, from 1891–'96, and held this position at the time of his death in 1896.

Mr. Reid was present at every convention of the association during his lifetime, namely, at St. Louis, Mo.; Cincinnati, O.; Philadelphia, Pa.; Kansas City, Mo.; and New Orleans, La.

As treasurer of the association, Mr. Reid was, *ex officio*, a member of the executive committee from 1891–'96, and his interest in association

matters was so great that he attended every meeting of this important committee as far as in his power, traveling even for this purpose to New York, Chicago, or wherever the special meeting was held.

In addition to the active part Mr. Reid took in the business affairs of the association, he showed a lively interest in the technical work of the association. He was a good speaker, and his discussions on technical subjects were invariably valuable and replete with practical information and suggestions.

Mr. Reid was a member of the committee on relief from 1893–'96 and served on numerous business committees.

He made several valuable reports as chairman of committees reporting on the following technical subjects:

At Cincinnati, O., in 1892, on "Painting Iron Bridges for Railroads."

At Philadelphia, Pa., in 1893, on "Creeping of Rails in Railway Tracks; Its Effect on Bridges and Methods to Prevent Injury to the Bridges."

At Kansas City, Mo., in 1894, on "Best Method of Bridge Inspection."

It can be truly said that Mr. Reid fulfilled every obligation and duty that he assumed either as a member, as an officer, or as the chairman of a committee of the association. He was never derelict in his work, nor did his interest in the association wane even with failing health for some time prior to his death.

Mr. Reid was a faithful and efficient officer, a valuable and hard-working active member, and a warm friend of every member of the association.

The committee on obituary reported, on October 21, 1896, suitable resolutions with reference to Mr. Reid's decease.

MEMOIR.*

LESTER K. SPAFFORD.

Charter Member,	September 25, 1891.
Third Vice-President,	1893–'94.
Second Vice-President,	1894–'95.
First Vice-President,	1895–'96.
Died,	January 7, 1897.

Lester K. Spafford was born near Howell, Livingston county, Mich., May 20, 1839. He died of consumption, at Phœnix, Ariz., January 7, 1897, aged 57 years, 7 months, and 17 days.

At the age of twenty-three, he enlisted in the One Hundred and Twenty-ninth Regiment, New York Volunteers, and served in the Army of the Potomac until the close of the war. Coming to Missouri

* Memoir prepared by Mr. James Stannard.

in November, 1865, he entered the service of the Hannibal & St. Joseph railroad, and through his untiring energy was promoted to the important and responsible position of superintendent of bridges and buildings. In 1876 he severed his connection with this road and accepted a similar position with the Burlington & Missouri River railroad in Nebraska, which he held till 1880, when he received the appointment of superintendent of bridges and buildings on the Kansas City, Fort Scott & Memphis railroad, which position he held with headquarters at Kansas City, Mo., until December 31, 1896, when he resigned on account of ill health.

He was married to Miss Kate Bailey, of Burkfield, Mo., November 8, 1868, who, with three sons and one daughter, survives him.

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Mr. Spafford was a charter member of the association, having joined at the first convention held at St. Louis, Mo., on September 25, 1891. He attended the fourth annual convention at Kansas City, Mo., in October, 1894, and the fifth annual convention at New Orleans, La., in October, 1895. Owing to the bad state of his health, Mr. Spafford was forced to stay away from the sixth annual convention held at Chicago, Ill., in October, 1896, but sent a cordial and fraternal letter to the association, explaining his condition and urgently requesting that his name should not be considered in connection with the presidency of the association, to which office he would otherwise, without doubt, have been elected.

Mr. Spafford served successively as third, second, and first vice-president from 1893–'96, and his popularity and the general esteem with which he was held by all the members are well attested by the unanimous adoption of the following resolution at the Chicago convention, in October, 1896:

"*Resolved*, That the members of this association extend to Mr. L. K. Spafford their regrets that he has been obliged to withdraw his name from the list of officers in line for promotion, and trust that with improving health he may be able to resume again active work in our association."

Mr. Spafford took a lively interest in the work of the association, and, in addition to serving on various committees and participating in technical discussions, he served on a committee which presented, at the fifth annual convention, at New Orleans, La., a valuable report on the subject of "Best Method of Spanning Openings too Large for Box Culverts, and in Embankments too Low for Arch Culverts."

On October 19, 1897, the committee on obituary reported suitable resolutions with reference to Mr. Spafford's decease.

MEMOIR.*

ROBERT MORTIMER PECK.

Elected Member, ...	October 18, 1892.
Member Executive Committee, . . .	1894-'95.
Chairman Executive Committee, . . .	1895-'96.
Fourth Vice-President, ...	1896-'97.
Died, ...	April 5, 1897.

Robert Mortimer Peck was born in Mason County, W. Va., April 29th, 1832, and died at Pacific, Mo., of congestion of the lungs, April 5th, 1897, at 8.30 a. m.

His early life was spent on his father's farm, and was uneventful. He received an ordinary education. A United Brethren minister took an interest in him, and the result was that he attended Mt. Pleasant college in Pennsylvania. After being graduated, he followed the ministry as a United Brethren preacher, and soon afterward was married to Miss Martha Ryan of West Columbia, W. Va.

Not long after being married, he gave up the ministry, learned the wagon making trade with his father-in-law, and went West, generally believed to St. Louis, Mo. He worked at his trade for some time, and when the Civil War broke out he engaged with the national government and assisted in the building of steamboats for use on the Mississippi river and while thus engaged earned the title of captain. After the close of the war, he located at Rolla, Mo.

In 1869 he accepted a position with the Atlantic & Pacific R. R., under Andrew Peirce. He was connected with this road until January 1, 1872, when the Atlantic & Pacific R. R. company leased the Missouri Pacific R. R., he then being appointed superintendent of bridges and buildings of the combined roads. He continued in this position until 1876, when the lease terminated, Mr. Peck remaining as superintendent of bridges and buildings of the Missouri Pacific Ry. company proper.

In addition, at various times he was superintendent of bridges and buildings of the M., K. & T., T. & P., I. & G. N., when those roads were included in the Missouri Pacific system.

At the time of his death, he was superintendent of bridges and buildings of the Missouri Pacific Ry.; St. L., I. M. & S. Ry.; C. B. U. P. Ry.; K. & C. P. Ry.; K. C. N. W. R. R.; A. & L. Ry.; K. & A. V. Ry.; and various leased, operated, and independent lines of the Missouri Pacific system, with headquarters at Pacific, Mo.

To mention any of his works as principal works would be slighting others equally as important. Suffice to say, no matter how difficult and extensive a work was, he always had it performed in a thorough and workmanlike manner. The performance of his work on bridges and buildings will forever stand as a tribute to his memory.

* Memoir prepared by Mr. F. W. Tanner.

Mr. Peck's grandfather was a German and came to this country in 1775, and settled on the Ohio river within three miles of where Mr. Peck was born 57 years later. His father followed farming for a livelihood, and on this farm Mr. Peck spent the first 24 years of his life. His mother was of Scotch-Irish parentage, and is believed to have been a niece of General William Henry Harrison.

Mr. Peck was a finely-built man physically, and was possessed of an unusually robust constitution.

His wife preceded him to the grave by nearly a year, having departed this life April 29th, 1896.

He left three children. Annie, his eldest child, is married to Mr. Wm. Smith, an engineer, and lives at Pacific, Mo. James C., his eldest son, is in business at St. Louis, Mo. His youngest son, who possesses his full name, is now nineteen years of age and is with his brother James at St. Louis, Mo.

Mr. Peck also left a brother, C. H. Peck, who resides at Grand View, Mo.

He possessed a generous disposition, and was exceedingly attentive and painstaking in the discharge of his various duties. He served the town of Pacific as mayor for several terms. He was a Mason and a stanch Republican, and possessed the good-will of all who came in contact with him.

Just a few weeks prior to his death, Mr. Peck had a bad attack of la grippe, but had apparently recovered, when floods came, damaging bridges on the I. M. & S. R. R. near De Soto, that required his attention. While there he exposed himself considerably and contracted a severe cold.

Returning to Pacific on Saturday, April 3d, he answered some correspondence and did not think his cold serious enough to require the services of a physician. On Sunday he spent a quiet day, coming to the office in the evening to sign some belated papers, returning home, saying he wished to put in a hard day's work next day. After a fair night's rest he arose at the usual time, ate a hearty breakfast, but complained of feeling very sick just as he was finishing the morning meal, stating he could not go to the office, and after writing a note to Mr. Fisher, his chief engineer, to come to his house to see about some important work, retired to his room to lie down, complaining of being very cold. The family physician and his son, Robert, were telephoned for at 8 o'clock. Before the doctor, Mr. Fisher, or his son arrived at his home he was beyond all earthly help, and in a few moments passed into the presence of his Maker.

On April 7, 1897, Messrs. E. Fisher, S. M. Ramsdell, F. W. Tanner, P. Carroll, and J. E. Featherston, who were general foremen of bridges and buildings on the various divisions and roads under Mr. Peck's charge, met at Pacific, Mo., and adopted resolutions of regret and sympathy for the bereaved family.

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Mr. Peck was elected a member of the association on October 18, 1892, at the second annual convention, held at Cincinnati, O. He served as a member of the executive committee for the year 1894–'95, chairman of the executive committee for 1895–'96, and was elected fourth vice-president at the sixth annual convention, held at Chicago, Ill., in October, 1896, which position he held at the time of his death.

Mr. Peck attended the fourth annual convention at Kansas City, Mo., in 1894, and the fifth convention at New Orleans, La., in 1895.

Mr. Peck was a member of the application committee from 1893 to 1896, and of the relief committee for 1896–'97, and served on several business committees.

While very quiet and reserved in manner, Mr. Peck was a fluent and versatile speaker on technical subjects when once started, and aided considerably by valuable contributions during technical discussions.

At the fourth convention, at Kansas City, Mo., in 1894, Mr. Peck was a member of the committee reporting on "Depressed Cinder Pits." At the fifth convention, at New Orleans, La., in 1895, he presented, as chairman of a committee, an independent report on "Methods and Special Appliances for Building Temporary Trestles over Washouts and Burnouts," which report was very complete and accompanied by numerous original sketches, illustrative of the practical methods employed and recommended by Mr. Peck. This report was widely noticed in the technical press as a very creditable and original paper.

Although a very busy man, having one of the most extensive railroad systems in the country to look after, Mr. Peck invariably indicated his great interest in the work of the association and was in thorough accord with its aims and tendencies. Business cares and the death of his wife prevented his attendance at the Chicago convention in 1896, and his death occurred during the following spring.

Mr. Peck was well known and esteemed by all the members of the association. General regret was expressed at the loss of such a sincere friend and valued member of the association. Without doubt, in due course of time he would have occupied the highest position in the gift of the association.

The committee on obituary reported, on October 19, 1897, suitable resolutions with reference to Mr. Peck's decease.

MEMOIR.*

ABEL S. MARKLEY.

Charter Member . . .	September 25, 1891.
Died	September 9, 1897.

Mr. Abel S. Markley was born near North Wales, Montgomery county, Pa., February 23, 1861, and died at the age of thirty-six years.

* Memoir prepared by Mr. Aaron S. Markley.

His father died in October, 1861, the same year Mr. Abel S. Markley was born, and his mother died in February of the following year. He was raised among relatives and strangers in Pennsylvania until 1878, when he came to Crawfordsville, Ind., where he served three years as an apprentice as horseshoer and blacksmith under his brother.

He began his railroad life in March, 1881, on the I. B. & W. Railway, now P. & E. Railway division of the Cleveland, Cincinnati, Chicago & St. Louis Railway, as bridge carpenter, where he worked until 1885, when he was appointed foreman of bridges of Champlain, Havana & Western Railway, now part of Illinois Central Railroad. At that time he lived in Urbana, Ill. In 1886, he was appointed superintendent of bridges and buildings of the Cairo, Vincennes & Chicago Railroad, now Cairo division of Cleveland, Cincinnati, Chicago & St. Louis Railway. In 1889, he was appointed superintendent of bridges and buildings of Pittsburgh & Western Railway, the position he held when fatally injured by being overcome by heat while on the top of Wildwood water-tank, fourteen miles from Allegheny, Pa., on September 9, 1897, falling a distance of twenty-five feet, landing on his head, and killing him almost instantly. The three appointments last mentioned were made by Mr. McAlcolm A. McDonald, he being the general manager of these roads at times stated. When the appointment was made on the C. V. & C. Railroad, the tunnel at Tunnel hill on this road was burning out, it being lined with timber. Mr. Markley's first task was to rebuild it, lining some 200 to 300 feet of it with brick, which work to-day is a substantial monument to his credit. He did this work without the assistance of any one whatever, in either the detail or general parts. He never worked at carpenter trade except as above referred to, working his way up on his own merits, Mr. McDonald being a stranger to him when first appointment was made.

Mr. Markley had only a common school education, which was received prior to his being sixteen years old.

He was married to Miss Ida C. Warfel, at Danville, Ill., on October 15, 1884. His wife and one child, eleven years old, survive him.

He was the youngest of seven children, six of whom still live.

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Mr. Markley was a charter member of the Association, having joined at the first annual convention at St. Louis, Mo., on September 25, 1891. He attended the third convention at Philadelphia, Pa., in October, 1893, and was appointed a member of the committee which presented an exhaustive report on "Depressed Cinderpits" at the fourth convention at Kansas City, Mo., in October, 1894.

The Committee on Obituary reported on October 19, 1897, suitable resolutions with reference to Mr. Markley's decease.

DISCUSSION OF COMMITTEE REPORTS

FOR 1895-'96.

CONTINUED FROM THE SIXTH ANNUAL CONVENTION.

I. Different Methods of Numbering Bridges. Should all Waterways be Numbered?

DISCUSSION.

Mr. Berg.—This question is divided in the committee report, it might be said, into three sections. The first one was the technical means of indicating the number on the bridge, namely, whether the bridge number is placed on a post or attached as a plate or block to the bridge and its location with reference to the bridge. The second question brought up in the report is the notation system. There are two systems of notation in use, apparently. One, known as the mileage system, in which the structures are numbered according to the mile on which they are located with certain letters or decimals of the mile to indicate their exact location, or rather to make it clear which particular bridge on the mile is meant. The other system, known as the consecutive or continuous system, in which all bridges are numbered right straight through as they occur starting from one end of the division or road. The third question or division of the subject as made by the committee relates to the feature whether all openings should be numbered, or, in other words, should closed culverts or pipes be included in the numbering system or only open bridges. In the latter case the point to be decided is at what length of a span should an opening be classed as a bridge. Some roads start with six feet spans, others start with ten feet spans.

Mr. Mallard.—I think our people have under contemplation adopting the system where the bridge is known by the mile on which it is, and then run by letters A, B, C, D, and so on. That is the system we are about to adopt. We have been using the continuous system. I can say this much, that as far as the mileage system is concerned, the location of the bridge being given by the number of the mile it is on and a letter, everybody on the road knows where it is.

Mr. Shane.—The committee in writing up this report last year was not prepared to go into the question very extensively and could simply give their individual opinions. I endeavored to draw the balance of the committee into that report with me, but to a considerable extent failed. I must say that had I the writing of that report over again would move to change it considerably. I think it advisable that all structures should be numbered. Some of the gentlemen take the position that when a structure could be made permanent it should be numbered, but when such class of openings as stone, box, or rail culverts could be discarded by the department of bridges and buildings and turned over to the track department the numbers could be dropped.

I say that time can never be, when any structure in this department can be turned over to the road department. There is no structure, permanent or otherwise, but what at some time will need some attention. I believe that numbering structures on the mile system would be much preferable, although the committee favored the consecutive system. It is true the supervisor is supposed to be able to locate a bridge by its name, or the engineer of maintenance of way may know all the openings and their exact location, but with the mile system anybody may come within a very short distance of the structure.

Mr. Harwig.—On the Lehigh Valley Railroad the bridges take their number from the mile post starting with No. 1. The first bridge would be No. 1. In case there is more than one bridge between the first and second mile posts, the second bridge would be No. 1A, the third No. 1B, and so on. The culverts and drain pipes are numbered in the same way as the bridges, except that we prefix the letter O to the number. The bridges,

culverts, and drain pipes on branches are numbered in the same way and manner as those on the main line, except we prefix the first letter of the name of the branch to the number.

My idea of numbering bridges is to give the number to the bridge according to its location; that is to say, take its number from the mile post which we will suppose is 51. The bridge is located nine-tenths mile further on. Its number would be 51.9. In numbering bridges in this way, if you do away with an opening or add a new one, you do not disturb any of the other numbers.

Mr. N. W. Thompson.—I believe I expressed my opinion on this subject quite fully last year. I agree with what Mr. Harwig has just said. If you abandon a structure you must either drop that number or re-number other structures. With the consecutive system you would have to change numbers to the end of the division; but with the mileage system only to the next mile post. I am in favor of numbering by miles and do not see any good objection to it.

Mr. Noon.—My method is consecutive numbering. I do not believe that it would be good policy to use either mileage or consecutive system that would require changing the numbers, for in that case we would lose the record of the structure. We have to keep a record of all structures. I would like to hear from members who are in favor of the mileage system, where they use the mile for the number and an initial or letter. On the road where I am employed we use consecutive numbers and on the branches we use letter "A" and next "B" and so on, and that could not be done in the mileage numbering.

Mr. Thompson.—We have mile posts on the branch as well as on the main line.

Mr. Bond.—It appears to me that we should first decide whether the structures and openings should be numbered, taking culvert pipes and everything as they come consecutively. If No. 2 was a bridge when it was built and afterwards a pipe should be placed in it, it would still retain its number on record. As it stands in the track it would be No. 2 if it was a pipe, trestle, or bridge. Men who are in charge of bridges become familiar with the method of numbering, and, if there are several

divisions, then a good plan would be to prefix the first letter or the first two letters to the number. For instance, say that the main line would have one hundred structures and the first branch from the main line might have fifty. The first structure on the branch would commence at 200 with an initial prefixed indicating the branch. If there were more than one branch the numbers on the next branch would commence at 300 with the initial prefixed. In that way the records would show what has been done with certain structures. It appears to me that the first question to settle is whether all openings should be numbered or not, and I think the question is properly raised at what length of openings they should commence to be numbered.

Mr. McIntyre.—I believe in the consecutive numbering of bridges, and on the branches begin with number one with the name of the branch. Bridges are easily kept track of in that way.

A Member.—Mr. President, I favor consecutive numbering of bridges, and think that all structures passing under the track should carry numbers. Where bridges are replaced with sewer pipe we make record of it, and our books will show what kind of a waterway it is. Our books also show the exact location of a bridge. Bridge No. 1 is at mile post 400, and our book will show that No. 2 is at 400. 2, or bridge No. 2 would be two tenths of a mile west of 400. If bridges and waterways are numbered consecutively, employés will get accustomed to their location.

Mr. Noon.—I would like to say one word in favor of consecutive numbering. Of course it is necessary to keep record of all structures, and also to keep record of the numbers on your inspection book. I have an inspection book arranged so that it is very easy on looking at the number of a bridge to find the location at the same moment. I would not be in favor of dropping a number or changing any number from the original, but if it was necessary to make any more openings, I would use one half, one fourth, or fractional numbers for the new openings.

President.—When you have a structure filled what becomes of the number?

Mr. Noon.—We simply keep it on our records and make notation of what has been done to it.

Mr. Carmichael.—Our bridges are numbered consecutively on the Union Pacific, and are located by number and mile post. We have a bridge book in which is kept a complete record of all bridges and structures on our line. The book gives the number and mile post where bridge is located, also the height, length, and kind of bridge, and age of construction. In case of a washout or burnout, a glance at the book will give the amount of material necessary to replace or repair the bridge. The superintendent and chief dispatcher have one of these books, and they have no difficulty in locating the trouble and protecting trains.

Mr. Shane.—It is true, all structures should be numbered in order that they may be designated, and in that way every one becomes familiar with their location, especially those who have to care for them. It is also true that there are others outside the bridge department that ought to know the location of a structure exactly. I had a forcible reminder of this last spring, when I had occasion to wire the trainmaster to have a train slow up at a certain structure. When I got into the office he requested me to furnish a bridge sheet, or, when I had occasion to notify him of the damaged condition of a structure, to be more definite as to the place and location of the structure. I had said such and such a structure was damaged so and so, but he was unable to locate it satisfactorily except that it was between two stations, but on what mile out of ten he could not decide, not having a bridge sheet at hand. I think after you have investigated the matter thoroughly, you will find it much preferable to number by the mileage system, and it will be more convenient for others outside the department.

President.—Do you not have a bridge book?

Mr. Shane.—Yes, sir, but every one does not have them.

Mr. Noon.—What system do you use?

Mr. Shane.—We have the consecutive number in practice.

Mr. A. J. Kelley.—I have made up two bridge books with the consecutive system of numbering, but I never did like it, and if I had my way about it I would not use it. I would use

the mileage system, as I think it preferable to the consecutive, for the fact is that you make up your book just as easily from mileage as consecutively. I wonld commence numbering, say, with 400 on mile one, and would number the first opening 400.2 or whatever distance it was from the mile-post. If the next was a covered opening, under ground, I would make it 400A. If the next was a trestle or an opening I would mark it 400.5, or whatever it might be. I would carry all my underground openings with the letters A, B, C, D, etc., on the bridge books.

Mr. Tanner.—There are many ways of numbering bridges and trestles in use on the various railroads in this country, and many different systems of designating openings. They all tend to cover the same ground, and I cannot see that it makes but very little difference what system is used. On the Missouri Pacific railway I would say the consecutive numbering is used. And in addition to the number, we give the exact distance in miles and hundredths of a mile, where the structure is to be found; also give the height, length, kind of structure, age of the bridge or trestle, and what kind of stream it crosses. We never have any difficulty in locating any of our bridges. The record of all our bridges and trestles is printed and put up in book form, a copy is furnished to all the officers of the road as well as to the train dispatcher, and this gives instantaneous information on the matter.

Mr. Zimmerman.—I can state that on the U. P., D. & G. road we have both the consecutive and mileage systems. We use principally the mileage system, that is, number all bridges on the mile the same as the mile number, and letter the bridges. We find it very good, and bridges are easily located by this method. We also have the bridges numbered consecutively on several districts of our road. This causes some confusion, as bridges bearing the same numbers but on different districts will be reported, and the district omitted, but as yet we have not decided to make any change.

Mr. Eilers.—We number bridges by the mileage system, and the letters, A, B, C, and so on. For instance take the main line: The first mile would be 286, and the first bridge west would be 286A, next 286B, and so on until we strike mile post

287, and then we would use 287A. The same way with our branches. Take the A., K., D. branch of our road; the first opening would be numbered 0A, and the second 0B, and so on until we struck mile post one, and then the first bridge would be 1A, 1B, etc. About a year or so ago we had a bridge burned out No. 41A. That designated at once that it was the first bridge on the other side of mile post 41. The dispatcher and all the men knew just where it was.

Mr. Isaacs.—We use the mileage system with the letters, and the only difference I know of between what we do and what the other gentlemen have related is that we keep our records by the station numbers in the profile book. The mileage and letters referring to a structure are recorded, but while they may change, the station numbers never do. The record of any structure is, therefore, always fixed.

Mr. Hanks.—I would like to ask for information, when you put in a new bridge between bridges already in how you would number it on the mileage system? Or if you take out a bridge and put in a new culvert, how would you number or designate it between those numbered with the letters in connection with the number? If a new culvert is put in between B and C what would you call it? We use the plus number in addition to the number established previous to new work going in.

Mr. Mallard.—I suppose you would have to call it little b or little c, but with us we use all numbers and not the letters. We have been numbering consecutively, but now we are going to change and if there should not be enough letters in the alphabet, I suppose we will have to double up the letters. On the part of our system where rice is raised, the farms are frequently only an "arpent" or about 192 feet wide, and each farmer has to have an opening. These openings might take up more than one alphabet.

Mr. Sheldon.—We use consecutive numbers commencing at No. 1 and designate them by the stations, as first bridge beyond such a station and the second bridge beyond such a station. We keep a correct record of all bridges, and, if a bridge is dropped out, we keep a record and let it stand as it is. Sometimes we have to renew them after being disused but we keep

them under the same record. We have a bridge book in which we keep record of each bridge and numbers and keep that in the office and find that it gives us much more accurate information than any previous record that we have had.

Mr. Fletcher.—I have not much to say on the subject of numbering bridges. We number consecutively and locate the bridges by the mile. We find it a very good working system and never have any trouble locating bridges.

Mr. Eggleston.—On the Chicago & Erie we number from one up and designate by the mile, using one fourth, one half, or three fourths between mile posts. We have blue prints made up for bridges on the whole system showing the number of the mile post, length of structure, depth of opening, height of structure, and name of the stream. All officers connected with the line are supplied with one of those blue prints, and in case of trouble he can see in a moment the location of the bridge and its construction.

Mr. Staten.—We have 2,079 miles of road and lots of bridges on them. We use the mileage system, numbering by the mile and tenths clear through on the main line to Cincinnati. On the branches we give them a letter to designate the branch. We do not number anything under ten feet. Our profile-book gives the little openings and they are located from that book. We also have a bridge book which gives size and kind of bridge, when it was put in, and all about it. We do not find any trouble in locating a bridge, and if we take one out, or change it, we still keep record of it. If one is created, we add one tenth to the previous number and get along just as well. I think this is the best way.

Mr. Danes.—Mr. Strain outlined our method of numbering bridges. I am in favor of numbering consecutively, and think that all openings and all structures should be numbered. On all of our trestles and iron bridges we use a wooden block, 22 inches long, made with three sides or in shape of a triangle, with the number of bridge on two sides. This block is bolted to a tie near the center of the bridge.

Mr. Hanks.—We use the consecutive numbers, and have a book also giving account of each piece of work and its relation

to mile post thereat. It also gives a complete list of all the work on the entire line, and the amount of material in each, and a profile of each piece of work, the location of the bents, and their relation to the cuttings, so that in case of washouts, fire, or derailed cars taking out work, you can very readily determine the amount of material needed, saving expense of loading unnecessary material not needed, thereby expediting the work at a time when each moment is of untold value.

Mr. McIntyre.—The best method is the mileage system on branches the same as on main line, beginning at No. 1 and so on. If an open culvert or bridge becomes disabled from any cause, our train dispatcher notifies all concerned. As he has access to our bridge records, he knows to the sixteenth part of a mile where the trouble is.

Mr. Austin.—We number consecutively at present, but our general manager has been talking about numbering by the mileage system. The only advantage I can see in that, is where a new bridge is put in, either a grade crossing or a crossing underneath, then you could call it by a half number. We number consecutively on the main line, commencing at Boston and running straight through; then commence back on the branch nearest to Boston and take them right or left, and follow them along in rotation after the main line. We number everything six feet and upwards; below six feet we do not number, and I have nothing to do with those under six feet. They come under the roadmaster as well as culverts and cattle guards. Within the last two years four under six feet have been eliminated by covering them with old rails and concrete on top of rails. With consecutive numbers you can locate openings very easily as they run clear through. We have blue prints giving numbers and location, and if anything happens they telegraph my office or the superintendent's, and he can locate just where it is either east or west, north or south, as the case may be. It is a handy way, and I do not think our people will change, but I would like to pick up some western ideas.

Mr. Taylor.—We do not number any culverts and no openings from four to ten feet. I like the mileage system, for if a

conductor of a train gets an order to look out for a certain bridge he knows where it is, and if a bridge is taken out it does not change the number of the next bridge. In the office in Chicago they probably have some way of keeping measurements. For openings between the miles we use letters A, B, C, D, and so on, and for openings on the next mile, if there are any, the letters are used again. We do not number culverts, and when a conductor gets an order for a bridge he knows that it is on that mile, and when he gets over that mile he is done with the trouble, and can go right along. We changed all our branches a few years ago, and now go by the name of the branch, and number the bridges in the same way, and that is by the mileage system.

Mr. Shane.—I have not yet heard any one make a suggestion during this discussion as to the method we have in view on our road. Numbering by the mile system is the plan which seems to meet with the most favor. For instance, take a division with 500 miles and the first three figures in the number are set aside as miles, and the first bridge on the division would be 501–1. The first three figures signifying miles, and the last two designate the bridge. When you come to the 490 mile, the first bridge would be 490–1, and the second bridge on that mile 490–2, and so on all the way through.

Mr. Eggleston.—How would a train crew understand that method of numbering? They would think it was bridge 4,001.

Mr. Vandergrift.—If the train men report it correctly, it makes no confusion, for as soon as the number gets to the superintendent, engineer, or myself, we understand it and know exactly where it is.

Mr. Mallard.—How about sending a work train to that bridge?

Mr. Vandergrift.—If they do not know where the bridge is, they can refer to the time table, and come within two miles of a station.

Mr. A. McNab.—A conductor is supposed to know the road and where he is going when sent to a burnout or washout. I always give the exact location of the trouble.

II. Drawbridge Ends, Methods of Locking; and under this head include Locking of Turn-tables.

DISCUSSION.

Mr. Mallard.—I would like to know if any one knows of any appliances that could be used on turn-tables to stop the jar of locomotives when passing on or off of turn-tables. Is there any such appliance? I have seen a plan with an eccentric wheel, but do not know anything about it.

Mr. Berg.—This phase of the question was taken up by the committee of which Mr. Mallard was chairman, and it was found that there seems to be no system of wedges, screws, or devices in general use for this purpose. I have previously stated that cushioning the circular turn-table rail on timber and also using timber coping around the pit had advantages in diminishing the effects of the blow somewhat. There is only one radical method that I know of, and that is by letting both ends of the turn-table actually rest on the circular rail. That can be done by a system of wedges or special devices, but it is very readily accomplished in any system of turn-tables with a lifting center, as for instance, a table centering on an hydraulic ram. When the table is to be swung, the hydraulic fluid lifts the center, and the ends clear the rails. There is an additional advantage, that in turning the table the center-pin friction is on the liquid and not on a metal disk.

III. Tanks—Size, Style, and Details of Construction, Including Frost-proof Protection to Tank and Pipes.

DISCUSSION.

Mr. Eggleston.—We are expecting to build three new tanks with steel sub-structures and 10-inch stand-pipes, but we have not got them up yet.

President.—I will call on Mr. Mallard to give us some information on tanks. While going over the Southern Pacific two years ago, down towards Morgan City, I noticed a steel tank being erected and would like to know if it proved a success, or if it would be a success in our cold weather.

Mr. Mallard.—It is a success as far as our business is concerned, but do not know how it would answer in the north. The average cost of such a tank is two thousand dollars, and it holds 60,000 gallons.

Mr. Shane.—I would like to ask Mr. Mallard if he is able to compare the metal and wooden tank as to service, and also as to the approximate cost of each kind.

Mr. Mallard.—I think two thousand dollars was the average cost over the whole road for an 18 by 24 tank holding 60,000 gallons.

Mr. Tanner.—We cover the tops of all our tanks with mineral wool, putting it about twelve inches thick; that protects top of tank from frost very well, and gives good satisfaction. To protect the outlet valve and goose-neck from frost, we make a casing around it the depth of tank joist, and fill it with concrete. The air chamber for protecting water pipes is constructed on the same principle as the refrigerator cars. We put in concrete foundation below frost line, to this we connect sills for the frost-proof chamber as follows: Take three common battens same length as the pipe, place them at equal distances around said pipe, and fasten by wire and staples; this answers a double purpose in providing a nailing place for the roofing felt that we wind around until it is four-ply thick. The battens make the first air space, also keep the felt from coming in contact with the pipe and getting wet. Outside of this place a rough casing of inch boards, and on this place four more ply of roofing felt, well nailing same to bottom of tank. Set up studding so it will form a six-inch air space, cover the outside with rough sheeting, and on this place four more ply of roofing felt; and finish with a good grade of ceiling boards over all.

Mr. Noon.—We make no protection except where we use steam for pumping, then we turn the exhaust up into the tank and find that good protection. Our tanks are supplied by gravity from springs on the hill.

Mr. Shane.—In regard to the accumulation of ice in the tub, I wish to relate an experience I had at one of our tanks. It gave us a good deal of trouble with ice, and we were so far from

the pump house that we could not reach it with steam. We turned the discharge pipe up over the outside of the tub, and by adding an "L" turned the water, and when up within two or three feet of discharge pipe it formed a current in the tub and it was rather successful, and we were not troubled with ice as we had been. It kept the water in continual motion, and as we pumped from 16 to 18 hours out of the 24 it answered the purpose.

Mr. McNab.—What was the size of the discharge pipe?

Mr. Shane.—Four inches.

President.—In my opinion the steel tub is the tub, but whether it will stand our weather in the northern climates is the question, and about which I would like something said.

Mr. Eggleston.—What does the cost that Mr. Mallard mentioned for the steel tank cover?

Mr. Mallard.—I included the cost of everything.

Mr. Bond.—The cost mentioned, if including foundation, frame, and everything complete, would just about offset the cost of the same size wooden tub with the same foundation. They cost about $2,800. As to the steel tub standing the weather in the north, I think if you gave it the same protection as the wooden tubs it would stand the pressure, and the service it would give would be much better than the wooden tub.

Mr. Shane.—It occurs to me that the gentleman is rather high in the cost of erecting the wooden tubs. I think in the neighborhood of two thousand dollars is rather high. We erected some 16 by 24 tanks with stone foundation, using felt roofing for covering, and the cost was $1,400, and it was as complete a tub as I have ever seen.

Mr. Tanner.—We lately constructed a tank 16 feet by 24 feet, with shingle roof, cedar pile foundation, and with regulation frame of 12 posts. This tank cost between nine hundred and one thousand dollars. It looks to me that the additional cost of the iron tank would be lost, an extra expense without any revenue whatever. The life of an iron tank must be short on account of the rust eating it up. I do not think there is anything so far found that will prevent rust forming on the inside of iron tanks; and rust, you all know, would very soon

destroy them. The chemical action of the water out here in the West would affect the iron of a tank badly. We find a large per cent. of alkali in most of the water we have to use, and this must undoubtedly destroy an iron tank in a few years. We often have to make repairs to water pipes that had not been in the ground over three years, on account of being eaten up with rust and all coming from the inside, caused by the action of the alkali water.

Mr. Shane.—I had occasion four years ago to take down an iron tub that had been built by our company and had been in service thirty-seven years, and when I took it down I would be safe in saying that it was as good as when it was put up. The outside had been kept well painted. We took it down with the intention of putting it up again, but could not do so, but it was not on account of any defect in the tub. It was taken down because it was too small for the place where it was used.

IV. Best and Uniform System of Report Blanks for Bridge and Building Department.

DISCUSSION.

Mr. Tanner.—We use the double system or duplicate blank by placing carbon sheets between the blanks. In this way two copies are written at one time. One copy is retained in our office and the other is given to the foreman to do the work. The bridge inspectors come to the office and I correct their reports of the work to be done, and decide the question of repairs from my personal inspection notes taken at the bridge.

V. Best and Most Economical Railway Track Pile-Driver.

DISCUSSION.

Mr. Isaacs.—I intended to have had a plan here, Mr. President, illustrating a pile-driver we have just gotten up and of which we have built three, two of which are in actual operation. I may say, in explanation of the subject, that our standards

require piles on trestles and all such structures to be driven with a batter, and that batter is determined by the originating lines from a distance of 25 feet above the base of rail. We do not fix the batter by inches to a foot, but have it fixed by radial lines from a point 25 feet above the base of rail, and this pile-driver is designed for that purpose.

COMMITTEE REPORTS

FOR 1896-'97.

PRESENTED AT THE SEVENTH ANNUAL CONVENTION DENVER, COL., OCTOBER, 1897.

I. Method of Heating Buildings Where Three or More Stoves are now Used.

REPORT OF COMMITTEE.

To the Officers and Members of the Association of Railway Superintendents of Bridges and Buildings.

Your committee appointed on Subject No. 1, viz.—"Method of Heating Buildings Where Three or More Stoves are now Used" respectfully present the following report:

Early in the year a circular was sent to the members of the association, asking their views on this subject. A number of replies were received, some of which explain the views of the writers so explicitly that we have concluded to give them in full as written. Your committee have been surprised at the view taken, by a large number of the members, of the circular sent out by the committee.

In selecting the plan of the station at Richmond, Ky., it was not done with the idea of having the members give their views of heating a building located there, but because this building would naturally require three or more stoves to properly heat it. A large number of the replies received indicate, however, that the opposite was the opinion of the writer, and, in consequence, we believe that when this point is thoroughly understood, some of those who recommend stoves would probably change their views on the subject.

It is the opinion of your committee that for cleanliness, comfort, and economy, hot water heating would be the best for a building of this size. While the first cost is greater than that for steam heat or stoves, still we believe that the first cost should not always be considered in a final decision. In erecting the building, while, with a hot water plant it would be necessary to build a cellar—which we would recommend placing under the baggage room—the cost of building one chimney would be saved. The cellar could also be used for storing the coal, which could be put in through a chute and thus avoid having an unsightly coal bin on the station grounds. All annoyance to passengers from ashes, dust, etc., would be avoided, and a great saving in coal and labor made, as it is no more trouble to care for a hot water plant, properly put in, than to care for one stove. All trouble from gas would be avoided, and certainly the rooms can be kept in a cleaner condition than where three or more stoves have to be constantly cleaned out and attended to.

In the matter of economy—four stoves of a size necessary to heat the building would consume about thirty tons of coal per year, while a first class hot water system would consume about twelve tons per year. Here we have a saving of about eighteen tons of coal each year, which your committee think would pay a large interest on the original investment.

Mr. George W. Andrews of the B. & O. R. R. writes as follows:

"Herewith you will find statement of various methods in use on this road for heating stations. In the small stations we use a No. 2 'Alaska' stove at a cost of about $12, set up. In medium size stations we have hot air heaters, which, while they give ample heat, are expensive to maintain. In large stations we have either steam or hot water. The steam is supplied by low-pressure steam boilers. In the station at Wilmington, Del., where hot water is used, we have the 'Perfect Hot Water Heater' made by Richardson & Boynton Co. of New York. For economy and general satisfaction I prefer the hot water system. The heater spoken of has been in use about eight years, and has not only given entire satisfaction, but has cost but little for maintenance. We wash it out every spring after fire has been drawn for the season, which is about the only work we have ever done to it. I am aware that many systems of hot water heating have been unsuccessful in the past, which I believe was due entirely to ignorance of the proper application of the principles governing hot water circulation. In the above-mentioned heater, as with many others now on the market, due regard has been given to these principles, and success has followed. These heaters occupy but little space, and the one we have uses about two tons of coal per month, and will heat 40,000 cubic feet of air-space."

Mr. J. P. Snow, Bridge Engineer of the Boston & Maine R. R., writes as follows:

"The system of heating universally adopted on the B. & M. R. R. is the two-pipe hot water system. For the station at Richmond, Ken., to which you call attention, I would recommend a cast-iron boiler of the Richmond, Gurney or Hub patterns, of proper size, placed in a cellar, and radiators giving a surface of about 1 foot to each 35 cubic feet of space in the three waiting-rooms shown, and in the toilet room and agent's office.

"I would distribute these radiators as well as possible around the room, placing them under the windows wherever practicable. In the baggage room I would run coils, giving about 1 square foot of radiation to 60 cubic feet of space. I would use Detroit radiators having valves and fittings of not less than the following sizes: 1 inch supply and return for radiators up to 40 square feet, 1¼ inch supply and return for radiators from 40 to 60 square feet, 1½ inch supply and return for radiators from 60 square feet upward. I would use flow and return pipes, giving 1 square inch of section to 60 square feet of radiation supplied. I would use an open expansion tank placed above the ceiling, automatically supplied if there is a water service convenient. I would also run a feed pipe to the lowest part of the boiler for filling the system whenever it is emptied. If there is no water supply convenient, the tank should be placed as high as possible, but in a position where it can be easily filled by buckets. The above amount of radiation is largely guesswork, as I am not acquainted with the conditions of climate in the latitude specified. In central New England or at latitude 42 degrees 30 minutes, we use a ratio of 1 foot of radiation to 30 cubic feet of space in waiting-rooms and ticket office, and 1 foot to 50 in baggage and express rooms. Farther north, or in latitude 44, we use 1 foot of radiation to 25 in waiting-rooms.

"Where the radiation is as much as 2,000 square feet, I should recommend a wrought-iron boiler of the 'Star' pattern instead of the cast-iron styles specified above.

"The hot water system is expensive in the matter of radiators when first put in, but it is quite economical in coal in moderate weather.

"In the coldest weather the amount of coal used is the same as it would be with steam, but at moderate temperatures, which obtain at least three quarters of the time during which a fire is needed, the hot water system takes decidedly less coal.

"What is known as the Paul Vacuum system is, I think, very good for depot heating, although it has not been adopted on our road. It is possible that it may require a little more attention than the system described above. It is essentially a steam plant with a small vapor pipe leading from each radiator or set of coils to an ejector operated by the water supply or some other force which will tend to produce a vacuum. This can be adjusted to work at any desired pressure, and its operation is wholly automatic. It is possible to lift vapor from the boiler, which will, of course, give off heat from the radiators when the water is at a temperature of not more than 160 in the boiler. It is then a mere matter of firing to obtain any heat required,—the plant being supplied, of course, with a safety valve set to blow at any desired pressure; the safety valve then governs the upper range of temperature and the vacuum ejector the lower range.

"With the hot water system it is entirely feasible to put on a pressure valve so that it can be run up to any desired temperature. This, however, is not advisable, it being better to put in more radiating surface, and allowing the use of a slower fire.

"I have not taken the time to compute the proper sizes of radiators, boilers, etc., for the depot illustrated, nor can I give you an estimate of the cost. The plans do not show a section of the building, so it would be impossible to get the exact cubical contents of the various rooms.

"I think the above, however, will give you an idea of the way the problem would be solved on our road."

Mr. George J. Bishop, of the C., R. I. & P. R. R., gives his views as follows:

"In reply to your circular letter of April 24th, 1897, on subject No. 1 'Methods of Heating Buildings Where Three or More Stoves are now Used'-

"In my judgment I would say steam heat; of which there are two systems, one known as the high pressure and the other as low pressure.

"I would say a low pressure with a one-pipe system. If I wanted a boiler enclosed with brick and wished to use hard or soft coal, Haxtun's Patent Vertical Base-burning boiler No. 10 is very desirable for that purpose. Height of boiler 64 inches; outside diameter, 53 inches. Diameter of fire box, 48 inches; number of brick, 4,000; total weight of boiler, 4,000 pounds; square feet of radiation, about 1,500; cost, about $300.

"This does not include the labor of inclosing the boiler with brick.

"If I did not want a boiler inclosed with brick and wished to burn coal, wood or coke, the Bromich No. 5 boiler gives very good satisfaction.

"Diameter of boiler, 43 inches; height of boiler, 84 inches; diameter of fire box, 33 inches; number of 2-inch flues, 210; square feet of boiler surface, 185; square feet of direct radiating surface, from 1,400 to 1,900; cost, $275 for the boiler.

"I would locate the boiler in the basement, under the baggage room, allowing for space underneath platform for unloading coal and for

storage, placing a coal hole in the platform for unloading coal and removing the ashes from the boiler when necessary.

"I would place standard vertical radiators in the ticket office, colored waiting-room, and baggage room; also circular radiators in the ladies' and gentlemen's waiting-room; all radiators to have sufficient heating surface for heating each room, located as marked on plan.

"For economy, I would recommend this system. I think you can get more heat from the same amount of fuel. For comfort, you have a steady heat; for cleanliness, steam heat is far superior, as the boiler is located in the basement; you do not have coal hods, pokers, tongs, and coal shovels to handle; no stove pipe to take down and clean out; no stove or stove pipe to polish up; no coal to carry as when you use stoves."

The following would answer for a general specification for heating this building by steam:

The entire building to be completely warmed by direct radiation, located in the waiting-rooms, office, toilet and baggage rooms, connected to a system of steam mains which will be suspended from the ceiling of the cellar.

The main to be connected to a boiler which is to be located in the cellar close to the vertical flue. The steam supply branches to the radiators are to rise to and through the floor and to connect with each of the radiators, inserting in the connection, close to the radiator, a lock shield stop valve, for the purpose of controlling each individual radiator.

The return pipe is to follow the same general direction as that of the steam, and it is to be located on the side wall of cellar near the floor, substantially supported. Branch vertical returns are to connect to each radiator, and are also to be provided with stop valves in a similar manner to that described for the steam branches.

To furnish and erect a boiler of any well-known make, such as "Toulmin," "Gurney," or any other equally good pattern, and is to be of ample size to heat the building in the coldest of weather without forcing.

The boiler to be provided and equipped with the usual set of fixtures, such as steam gauges, try-cocks, safety-valve, damper regulator, fire tools and all other necessary fixtures to render it complete and ready for steam.

The boiler to be covered in a proper manner with asbestos plaster at least 1½ inches thick, applied over wire mesh.

The boiler to be connected to the vertical chimney by means of a heavy wrought-iron smoke pipe, with a pivoted damper in its connection.

To have radiators located throughout the building, to be of the sectional type of an ornamental and neat finish. Each radiator to be provided with an automatic air valve of the "Onderdonk" or "Jenkins Bros." patent. They should be distributed as follows: Ladies' waiting-room, ladies' toilet, small waiting-room, office, gentlemen's waiting-room, baggage room.

The above radiators are to be of ample capacity to warm the rooms in which they are located to seventy degrees in the coldest winter weather.

After steam has been put on, all of the radiators and exposed piping throughout the building to be neatly bronzed with the best gold or silver bronze color, over a good sound coat of sizing. All the exposed

iron work around the boiler and in the cellar to be painted with black asphaltum varnish.

The above represents a complete steam heating apparatus left in perfect running order, with steam on, and would cost in the vicinity of New York, about $328.

For the heating of this building by hot water, using the same number of radiators, locating the boiler in the same position, running the pipes in the same general manner as specified for steam, equipping the radiators with valves, etc., including the same guarantee of temperature, etc., would cost about $379.

The approximate amount of coal that would be consumed in the steam heating apparatus would be about thirteen tons for a winter of six months, and, with careful management, the hot water system would consume ten tons of coal for the same period. This amount would, in all probability, be reduced if the caretaker of the boiler was careful.

In conclusion, your committee would like to have a full and complete discussion of this subject, believing that it will be of interest and value to every member of our Association.

Respectfully submitted,

J. H. Cummin,
G. W. Hinman,
G. W. Markley,
Wm. Berry,
Committee.

DISCUSSION.

Mr. Cummin.—I have nothing additional to say at this time in regard to the report, excepting there is one little matter in heating stations with hot water that has been called to my attention, namely, where they are not supplied with city water works, but that objection I do not think will hold good, because the amount of water consumed is so small, that it is very easily obtained. A tank can be placed in a suitable part of the building attached to a force pump, and the agent in a very few moments can supply all the water necessary to keep a plant running of sufficient size to heat the building shown on the plan. The amount of water consumed each day would be small.

Mr. Shane.—I would state that we have a hot-water heating arrangement in our train master's office, and although we have the water in the building it is not connected at all, but is filled by hand.

Mr. Yereance.—There is only one thing that I care to bring up. Considerable stress was laid in the report in connection with the station at Richmond, Ky., as being the one under consideration. What were the attendant circumstances that led to

the selection of the station at that point ? In the discussion, probably the most important points are whether other company buildings to be heated are located adjacent to the passenger station, the capacity of the buildings to be heated, and the severity of the winters in that locality. I think these conditions determine the use of hot water or steam.

Mr. Sheldon.—We have some of our local stations heated by hot water. I have always been in favor of steam for the stations. One thing about my experience with hot-water heating is that you cannot force it as you can steam. You must be sure to have radiators sufficient to heat rooms in extremely cold weather or it will not prove satisfactory; but with steam you can put on more steam and increase your heating capacity by increased pressure on the boiler and heat wherever you choose. Still the general trend of opinion is for hot-water heating in most places.

Mr. Danes.—We have no depot buildings that are heated by hot water. We have a hospital that was erected last year that is heated by hot water and has proved a success, I think has probably given better satisfaction than steam heat.

Mr. J. B. Pullen.—We have in use a steam heater which heats the waiting room, superintendent's office, division engineer's office, dispatcher's office, and the dining room, and the plant cost $1,200. It has been in operation three years and has given perfect satisfaction. Have no trouble whatever. Use slack coal altogether.

Mr. Harwig.—We have some buildings heated by steam which are located all the way from 100 feet to 1,500 feet away from the boiler. I do not think we could use hot water in such cases. Personally I am in favor of hot water for heating buildings. I call to mind now a small building in which we keep oil that is heated by hot water and it gives the best satisfaction of any heating plant on our system. It is the only hot-water plant we have.

Mr. Bishop.—I have no buildings on my division heated by hot water. We have shops, depots, and other buildings heated by steam. At one place we have a depot 2,000 feet away, that is heated by steam. The pipes are hung overhead, on poles, and cov-

ered with asbestos covering, and on top of that galvanized iron, and they give perfect satisfaction. The difference in cost between heating by steam, and three stoves, for a building, I cannot give; but I think it would be in favor of steam heat.

Mr. Hanks.—We use both hot water and steam,—steam for larger buildings. Small stations are invariably heated by hot-water system. We use less coal with that system than with the ordinary coal stoves. We use soft coal; have no trouble and less dirt in connection with it than in any other way we have for heating.

Mr. Cummin.—In reply to a portion of Mr. Yereance's remarks in regard to the location of the building and its proximity to other buildings, it seems to me that the object of the committee who selected this subject was not to provide a system for a number of buildings in close proximity to one another, but it was to give a method of heating for local stations, which would take three or more stoves. At our terminals we use steam entirely. Our terminal station at Long Island City is 75 x 220 feet. The first floor is occupied with waiting rooms, toilet rooms, and ticket offices, etc., while the entire second story is divided into offices. The same steam plant also furnishes steam heat for all the trains standing in the yard, and for a few small repair shops. At Flatbush avenue, Brooklyn, there is a terminal station that has also express and baggage room which are over three hundred feet away from the other rooms and we use steam there. But my understanding is that the committee's intention was to confine the report to local stations requiring three or more stoves to heat. I think this is the view the membership have taken of this subject in giving their opinions.

Mr. Isaacs.—Although Mr. Cummin prefers to confine the subject to single stations, perhaps it would be well to get an expression from the members of the advantages in general of steam or hot-water heating plants. At Indio, Cal., there are ten cottages for consumptives. These buildings are scattered over 600 feet in length. We have quite a large pumping station about 300 feet away from them. Here a hot-water system has worked very well. We made a pit, 12 feet deep, for the boiler, and heated the water with exhaust steam from the pumping plant.

The only change made from the customary details in putting down pipe was that we specified all the supply pipes and return pipes the same size throughout. We boxed them in rough boxes and supported the pipes away from the side of the box. Put another box outside again, filling with cinders between, so as to insulate the lead pipe as much as possible. The return pipe was simply put in the ground. This plant also heated a hotel at the same station about eighty feet away.

Mr. Eilers.—We do not use the hot-water system at all. In our large depots and buildings we use steam, and in small buildings we use stoves.

Mr. Montzheimer.—We use steam heat at the large stations and have hot-water heater at some. Where we put in modern closets we use Baker heaters that came out of coaches, the coaches now being heated by steam. The pipes run through the closet to protect them from frost. We find that very satisfactory for the modern closet, where the closet is in a detached building.

Mr. N. W. Thompson.—I have had no experience with hot-water heating. Some of our buildings and the office of the superintendent of motive power and the telegraph offices are heated by steam, but I do not know much about it, as the plants come under the motive power department. Out on the road we have put in several hot-air heaters and find them quite satisfactory in heating stations 30 x 50 containing three rooms. We have a large coal stove in the basement, covered with galvanized iron casing, about eighteen inches greater diameter than the stove, leaving spaces to get in to the doors. We carry the pipes to the middle of the room and put in a register. We have had no trouble in heating the rooms properly and at a very slight expense. I do not think the expense of coal is over twenty-five or thirty per cent. of the cost when we used the stoves. We also heat inter-locking towers in that way and the expense is light. It also saves all ashes, coal, and smoke in waiting rooms.

Mr. Cummin.—How low does the temperature get with you?

Mr. N. W. Thompson.—Twenty-five or thirty below zero.

Mr. Hanks.—At terminal station at Luddington, where we

have a great deal of cold weather and severe winds, and the station doors being open a great deal, Mr. Brown overcame the extreme cold by placing in each register about twenty per cent. more tubing for radiation than manufacturers commonly figure sufficient for our wants, and find that when the doors are not in use often that the fuel used ordinarily for one stove can heat the building so that it is rather uncomfortably hot for all that work there. There is no trouble by adding twenty per cent. to the radiation to get the required amount of heat with a small amount of fuel.

President.—Have you ever tried storm doors? I think you will find them a great benefit.

Mr. Hanks.—No, sir, not at this point.

Mr. Austin.—We have some cold weather in our country, but not so cold as farther north. Mr. Cummin says that small stations is the point instead of large ones. Most of our stations are heated by steam or hot water. We have three or four steam-heating plants, which, besides heating the station, are used for heating cars at the station that have been sidetracked for the night so as to have them warm before they start out in the morning. For small stations, I think hot water is the best; it is easier to take care of. I have one station with a waiting room and ticket office, 15 x 38 feet, that I heat with a Johnson heater, the same as we used to heat cars with. I use coils running around the room, with a radiator in the ticket office. It is all on the ground floor. There is an open circulating tank in the attic. It does not take any more coal than a small stove to do the heating. In several stations I have done the same way and these heaters are more economical than stoves or steam, as they practically take care of themselves, requiring about six or eight gallons of water extra during the season. My idea individually is, that hot water is the best for stations, in place of two or more stoves.

Mr. Cummin.—Before this subject closes I would like to say that there is one little matter in regard to stoves that we have not heard about. If the agent at the station is to look after the stoves, as a rule you will usually find one in his office. If you go into his office, no matter how cold the weather is, you will find

the agent is quite comfortably situated, but the passengers as a rule have to take their chances. If he has two or three large stoves to take care of, you will generally find it rather indifferently done, whereas if he has a hot-water plant, or a steam plant, the passengers will be as well taken care of as the agent. Station buildings are never so clean with three or four stoves as with steam or hot-water plant, as that is situated away from the station rooms proper.

President.—In regard to Mr. Cummin's remarks about the agent being warm and the passengers not; we have a method of overcoming that difficulty. We place our stove in the waiting room and have a screen between the waiting room and the ticket office.

Mr. Cummin.—That might do on the Wabash, but in some sections you would have to furnish your agent a stove.

Mr. Shane.—All of our local stations are heated with stoves, but I think they are generally very unsightly and take a great deal of room, and it is hard to keep the place clean with the dust and coal and ashes that accumulate. I never saw a waiting room that was heated with a stove that was comfortable in very cold weather.

II. The Most Suitable Material for Roofs of Buildings of all Kinds.

REPORT OF COMMITTEE.

To the President and Members of the Association of Railroad Superintendents of Bridges and Buildings:

Gentlemen:—Your committee on "The Most Suitable Material for Roofs of Buildings of all Kinds," beg leave to submit the following report:

In the beginning, we would state that this report is made largely from replies from members to our request for information, from our own personal experience, and a close observation of the many excellent methods and materials now in general use. We have not taken up the matter of rafters or construction, but confined the report to outside covering only. We consider a good roof must be rain-proof, fire-proof, light in weight, durable, attractive, economical, and not liable to get out of order. In giving names of manufacturers, we have endeavored to give those widely known, and strongly recommended for the special points under consideration, namely, durability and cheapness.

From a close study of the subject, we find that for small, cheap buildings, such as section houses, water tanks, tenement houses for employés,—that are away from danger of fire from locomotives,—the preference is for shingles, manilla roofing, or rubberoid. In using shingles, the Duluth, South Shore & Atlantic railway is very fortunate in having a number of shingle mills located along the line, and in using cedar piling altogether; they take the cedar pile heads, after being driven and cut off,—these range from 16 inches to 4 and 5 feet long,—load and ship them to the nearest mill, where they are made into shingles of the best quality at 70 to 85 cents per thousand, costing laid per square $1.50 to $2. Ordinary pine shingles laid on, cost $2.50 to $2.75 per square; Fay manilla roofing, $1.50 to $4.50 per square; the rubberoid of the Standard Paint Company in general use for all kinds of buildings is certainly one of the cheapest and most durable, as it is also one of the lightest and most neat in appearance; this costs from $1.50 to $5 per square laid. Asbestos, another excellent roofing material preferred by many, would cost about the same by two leading firms, the Sawyer Paper Company and the Johns Manufacturing Company; laid complete, it would be about $2.30 to $3.50.

Now for warehouses, coal sheds, train sheds, and roundhouses, there is an excellent felt graveled roofing of the Ready Rock Asphalt Company from $3 to $5.50 laid per square; and for the better class of buildings, such as stations of stone or brick, the choice is most general for metal or slate, as durability and attractiveness are secured by both. There is the National Sheet Metal Company, which would cost from 5 to 16 cents per square foot; the N. and N. G. Taylor Company, which is from $7.50 to $15 laid per square. One of our members strongly advises for any roof above one-third pitch, the Maine slate, which has stood the test of 35 years on his road. There is the Scotts' Extra Coated Guaranteed Roofing tin of Follansbee Bros. Company,

Pittsburg, which has many excellent qualities and gives good satisfaction. The Bangor slate is from $5 to $8; the tin roof about the same. There is another roofing with strong endorsements, the Ludowici Roofing tile; these are interlocking clay shingles at $6 per square. It is claimed neither wind nor storm, nor vibration of building will break them; there are no nails to rust and they are not affected by smoke.

In considering this subject, it is manifestly impossible for us to say, except from our individual experience, which is the most suitable material for roofing of all kinds of buildings, and a general answer cannot be given to cover all cases, owing to the difference in climate, and the prices of building material in various sections of the country. Our correspondence has been quite extensive and covers a wide range of observation and experience from 10 to 50 years. In many cases these letters have been very carefully written to the smallest details of cost and labor, but, in order to make this report as short as possible, it is considered best to give the subject in general terms.

We are aware that much more might be said, but we will only add that our thanks are due to the members for their timely assistance. Especially do we thank Messrs. Bishop, Eggleston, Riney, Markley, Andrews, Austin, Cummin, Patterson, and Berg.

W. M. Noon, *Chairman*,
G. W. Turner,
N. W. Thompson,
Committee.

DISCUSSION.

Mr. Cummin.—That subject covers a wide range. My opinion in regard to car sheds and flat roofed round houses and freight houses where there is not too much pitch to the roof is that a good gravel roof is the most economical roof that can be put on the building. In regard to the cost of roofs, that will vary in different sections of the country a great deal; not only in the price of material but also in the price of labor. I do not know how it is with most of the members present, but in our location such work as that is controlled as far as price is concerned by the unions, as they determine the wages. The cornice makers and the tin workers have just closed a strike around New York and Brooklyn, where they succeeded in getting three dollars and fifty cents per day of eight hours. I suppose that in some sections you would consider that pretty high wages, but that is the rate of wages in our section to-day.

For station building where there is from ⅓ to ½ pitch in the roof I think a good slate roof is about as substantial as any. Of course if you were going to complete the building with some

of the finest touches on it, tile is good, but you have to go down into the company's pocket and pay $30 to $32 per square laid on the roof.

Tin roofs properly applied and the right kind of tin will last a good while, but the great difficulty we have in the use of tin or galvanized iron or metal of any kind is the salt air. Our road is entirely surrounded by salt water, and in addition to the salt air we have to contend with what we call sea fogs, which will come up inside of an hour and you can just see them roll right in from the ocean. When they strike metal or tin you can almost imagine you see the paint coming right off.

In my opinion the material for roof construction varies a great deal according to the part of the country in which it is to be placed. For roofs, for shops and round house, I think, as I said before, that a first class gravel roof is about the best material you can put on. For gutters and leaders we use galvanized iron. In some places we are using copper.

Mr. Shane.—We would be governed by the kind of building as to what kind of a roof would be best. For freight houses and warehouses I much prefer standard felt roofing. It is cheaper and easier to put on, and is almost absolutely fire proof. We have had one or two severe tests of fire, and find that it stands fire about as thoroughly as anything we ever used. For suburban buildings we confine ourselves to slate. Sometimes where we have a gutter I have discarded tin and put in copper, but we do not use gutters at all where we can dispense with them.

Mr. N. W. Thompson.—So far as my experience goes on all roofs of $\frac{1}{4}$ pitch or more I prefer slate. On flat roofs of course we have to have gravel, but we have not been successful in getting a good gravel roof. Nothing lasts over ten years, and a good roof ought to last longer. We sometimes let contracts where they guarantee them for ten years and the contractor has a good deal of repairing to do, and when the time is up the roof is almost worthless. Slate roofs last well and are economical. For depots, telegraph towers, and watch houses we use slate altogether. We are considerably troubled with rusting of metals. We put gutters on everything, but our

gutters have been giving out very fast and we have started to use copper gutters.

Mr. Sheldon.—It is our custom in many of our smaller local buildings to use cedar shingles, but one serious objection to this is fire. For larger buildings we are using tar and gravel and have had very good results. It lasts from twelve to eighteen years. We have it on round houses where it has been for twenty years. Of course it has had to be looked after a little. We have an attachment gutter fastened to the outside, that can be removed without interfering with the other parts of the building. With us galvanized iron does not last a year without some defect, and in three or four years it is gone. For better class of buildings I am in favor of copper roofing. With slate we have not had good results, but it may not be the fault of the roof, but I prefer a copper roof to a slate roof.

Mr. Patterson.—I have recently put on to a car house about one hundred squares of the Perfected Granite Roofing, at a cost of $3.15 per square. I like it very much for such buildings. It is cheap, easily put on, and I think it will be durable. It is very satisfactory thus far. I shall watch it with a good deal of interest, and have no doubt it will prove all we expect.

Mr. Hanks.—A slight objection to the use of slate roofing in railway buildings outside of depots is that there are very few round houses and machine shops but have skylights and ventilators. You have to repair them, and you cannot pass over slate roof without injuring it or cracking the slate. That has been our experience, and also with our union depot where our wires have been blown and broken off. We have always had to follow up these repairs with slate roofers.

President.—What did you say about the wires being broken off?

Mr. Hanks.—The electric lighting wires have been broken off the union depot by lightning and heavy winds. We had very heavy winds that took off a portion of our machine- and car-shop roofs, and they were slate.

Mr. Bishop.—On our buildings with flat roofs, such as round-houses, we have put on a three-ply gravel roof, which

lasts six or seven years, and which were put on by contract. But I think a good gravel roof can be put on (say four- or five-ply) which would last from eight to eleven years. On our large buildings, such as shops, and depots, where the roof is steep, we use slate, which I find is very unsatisfactory, on account of the slate being large in size, and the hail-storms damage the slate, and the winds blow them off. We had one hail-storm this season that broke about 3,000 slate on one building. On all buildings where slate is used, copper should be used for gutters, as tin or galvanized iron will have to be replaced about every five or eight years, and then kept well painted. On small local stations we use shingles, which make a very durable roof, and cheap. I would not recommend shingles, however, on a roof with less than five to twelve inches pitch.

Mr. Hanks.—I would like to ask if any of the members have had any experience with roof-sheathing seven-eighths or three-fourths inches. We have trouble with sheathing on our gravel roofs.

President.—What distance did you place the supports?

Mr. Hanks.—Sixteen inches.

President.—I think you would overcome that particular difficulty by putting them nearer together.

Mr. Yearance.—In our section we favor earthenware or tile for roofs. On some of our round-houses we have dispensed with the use of gutters; in the case of the ordinary flat roof for passenger waiting shed or freight shed we consider that either the standing seam tin or gravel roof serves the purpose excellently, but the best testimony as to the value of the latter that I can offer is to call attention to our large freight piers at Weehawken. Those roofs have been down there about fifteen years, and are in good condition to-day. The appearance might be improved by an additional stock of gravel, but they are in good condition. On our elevator at Weehawken we have slate for siding, but for unknown reasons, that may be due to unsatisfactory construction, it gives us much trouble.

Mr. Eggleston.—I am in favor of slate roof for ordinary station buildings, or in fact for nearly all buildings with one-fourth pitch or over. For small buildings, shops, etc., we have

used considerable gravel roofing. We get Chicago parties to put it on, and they put on the gravel roof four-ply, and give guarantee for five years, at $2.25 per square and furnish all material. We have used considerable of the eastern granite roofing that Mr. Patterson spoke of and it gives very good satisfaction. We only use it on small out-buildings and sheds. We took the slate off the roof of an old round-house to relieve the load, and laid it with eastern granite roofing. It will be on two years next month and we have had no trouble with it. The eastern granite roofing is delivered to us at $2.25 per square, and the cost of laying will run from about fifty to sixty cents per square. Anyone who can drive a nail can lay it; it is very simple to put on.

Mr. Cummin.—I would like to say that I think it depends a great deal upon who you get to put your gravel roof on. My opinion is that it is a mistake for every little job of gravel roofing that you have to do to have bids and estimates sent up from different parties. All the gravel roofing that has been done on our road for the last seventeen years has been done by one company. We have a contract with them to put on gravel roofs at a certain price per square no matter where the job may be. I believe they are the largest roofing company in New York; they have been in business there for over a quarter of a century, and we never have had any difficulty with the lasting qualities of the roofs. I believe it is a mistake for every little twenty or thirty dollar job you have to send out for bids. You get figures from small concerns, and they may bid low enough but are not always reliable. In fact, with some of them, as long as the roof is tight until they get through that is all they care; but, if the company will search out a first-class roofing company to do all the roofing at a certain price, I do not think there will be any trouble with the use of gravel roofs.

Mr. Strain.—For shops and round-houses, I am in favor of gravel roofs, and it is the intention of the Wabash Company that when any extensive repairs are to be made on a slate roof, gravel is to be substituted. For small buildings we use shingles. One gravel roof that has given entire satisfaction is on an old building at Springfield. It was built in 1856, and the

same roof is on the building yet, and is in fairly good condition.

Mr. Bishop.—What is the pitch of that roof?

Mr. Strain.—About three-fourths of an inch to the foot. Our standard is one inch to one foot.

Mr. Eilers.—We are using shingles on all our small buildings, also stations, but of late years we have been trying the mica roofing. We put up a large round-house at Ottumwa and used the mica roofing. We have been using it for the last six or seven years. We have gravel roofing on several of our round-houses. They were done by contract and give very poor satisfaction. So far the mica roofing is ahead of the gravel roofing.

Mr. Yereance.—I would like to ask for information in relation to some cheap roofing materials made in Newark, N. J. If anybody has had experience with such materials, I would like to hear what they are worth.

Mr. Harwig.—I am not able to give any light in answer to the question just asked by Mr. Yereance. Would say, however, that there is a company located at Jersey City that manufactures roofing. I cannot add anything to what has been said by the different members on this subject. My views are about the same as expressed here by the other members. We have our troubles the same as most of them with slate, galvanized iron, tin, and gravel.

Mr. Staten.—We use all kinds of roofing. I believe we have one building covered with a roof made of patent brick. They use brick material, burn it and make it into shingles. They are really shingles of clay. We have a very fine building covered with that, but it has only been on about a year. If anyone else knows about that kind of shingles I would like to know what satisfaction they give. I believe they are made at Huntington, W. Va. Slate does not give very good satisfaction on round-houses and machine shops where there is steam, etc., to contend with, on account of nails not holding securely.

Mr. Shane.—We have a suburban station out of Cincinnati that is covered with the roofing material Mr. Staten mentioned and I am ashamed of it every time I pass. There is always

something the matter with it and every time a man is sent to repair it it looks worse. The only remedy is to take it off altogether.

Mr. Mallard.—Instead of gravel we use broken sea-shell. I think the best policy is to follow up repairs as soon as a spot becomes exposed. When it is first noticed, if it is touched up with roofing-pitch and more gravel put on, our gravel roofs would last a great deal longer.

Mr. O. H. Andrews.—We have two round-houses covered with gravel roofing, and both are giving good satisfaction. The gravel may occasionally be blown off when we have extreme winds. I watch them closely each year, and when I notice the gravel is wearing thin in places, I send a man to mop them over with tar and put on more gravel. They have been in service eleven years and are still in a good state of preservation and the cost of repair has been slight. In regard to gutters, we have found sheet-lead to be the most durable.

Mr. Foreman.—Until about a year ago we covered our roofs with gravel roofing, but at present we use slag roofing, made from furnace slag. We find this gives better satisfaction than gravel. To make a good slag roof, it is very important to have a good foundation for the covering and a pitch of not more than three inches in twelve inches; the rafters should be near enough to each other to make it firm, when planked or boarded, so that it will not spring under the feet; the boards should not be less than six inches wide, they should be tongued, grooved, and dressed to a thickness so as to have an even surface for the covering and laid diagonal. The experience with gravel roofs on engine-houses on the Reading System has been, they last from ten to twelve years, with very little repairs, but after that time they require extensive repairs. Slate roofs last from fifteen to twenty years. We have had no tile roofs on engine-houses, but had them on several depots; they were very unsatisfactory, giving bad results from the day they were put on until taken off. The gutters on slag roofs are made of slag; on other roofs some are made of tin, others of sheet-metal. I consider the most important part of a roof, is a good foundation for the covering.

Mr. A. J. Kelly.—I think we are mostly agreed on the matter of gravel roofs for round-house buildings where gases accumulate more or less. I do not believe there is any better roofing material for that class of buildings. It is cheap and easy to repair, and if a roof lasts eight or ten years, that is certainly long enough for a roof costing from $2.50 to $3 per square. It is easily repaired. Any bridge foreman can make the necessary repairs where the gravel washes off. All that is needed is to pitch it over and put on more gravel and it is as good as new. For other buildings slate is preferable to any other roofing material that we have yet tried, where we do not have to climb over them and are not interfered with by high winds and storms. For smaller buildings shingles make a very good roof, if properly painted, and where they are too close to the track, I believe sanding would help protect the shingles.

Mr. Vandergrift.—On my division we use slate nearly altogether, and on round-houses, machine-shops, and buildings of that kind, where they come in contact with coal smoke and gases we put on slate with copper nails. The roof on the machine shop at Huntington was put on in 1870 of slate, and very little repairs have been done on it since 1872. If a man will take off his shoes when he has to go on a slate roof and put on gum shoes, he will have no trouble in getting over it and will not damage the slate. The sheathing should be made to a uniform thickness. All our local buildings and those that come in contact with the railway are covered with slate, because in past years we had a great deal of trouble with fire. Shaved, white pine shingles will make a first-class roof, but in dry times they are dangerous on account of fires. My house is covered with shaved, white pine shingles that were put on twenty-five years ago, and it is still a good roof. Any new buildings, or stations, that we put up now are covered with slate, but on machine-shops and round-houses we use slate with copper nails exclusively.

President.—Do you use tar paper between the sheathing and the slate?

Mr. Vandergrift.—Yes, one-ply. We have several round-houses put up five or six years ago, and the slate was put on

with common nails and it would not answer, so we took the slate off and put it on again with copper nails. That was two years ago, and we have had no trouble since. Gutters that are put on with galvanized iron do not last two years. We took the gutters off and replaced them with timber gutters and have had no trouble with them since.

Mr. Cummin.—I intended to bring up the same point in regard to slate roofs, namely, that the roofing plank should be dressed to a certain thickness and be sheathed with paper or felt.

Mr. Vandergrift.—We get our slate comparatively cheap. It costs us from $3.10 to $4 per square, which makes the roof cost from $4.10 to $5 per square after it is laid.

Mr. Berg.—The last remarks of Mr. Vandergrift bring out a point I was about to mention, namely, giving the prices on the different material in different sections, as of course they vary considerably. It would be well to have the members from different sections mention the prices, as in many cases the choice of material and hence the standard roofing materials in use on a railroad are dependent on the question of local cost.

Mr. Cummin.—We use cedar shingles and they are $9.00 per thousand, 6 x 20 inches.

Mr. Mallard.—$2.25 per thousand, 6 x 20 inches, sawed cypress shingles.

Mr. Staten.—Cypress shingles cost $3.00, 5 x 16 inches. We use a very small shaved shingle and find it cheap.

Mr. Reynolds.—We pay in our section from $1.50 to $2.25 per thousand for sawed cedar shingles; and for best white pine shingles $1.50 for common and $2.50 for clear, 16-inch shingle, and lay them about 4¼ to 4½ to the weather.

Mr. Bishop.—Pine shingles cost $2.40 per thousand and it takes nine hundred to lay a square. They are four inches wide and are laid 4½ inches to the weather.

Mr. Danes.—In regard to roof for all round houses and shops I am in favor of gravel roofs. The gutters we make by sloping the board back on roof and using the same material as on the roof and use galvanized iron for down spouts. On small buildings we use sawn cedar shingles, 16 inches long.

Mr. Cummin.—When I gave the prices of labor in the vicinity of New York I hoped it would induce the other members to give prices of material and labor in their sections. I now give you the different prices. A first-class tin roof costs us eight cents per square foot, painted one coat on the under side before being laid. Slate, from nine to ten cents per foot. Spanish tile, $33.00 per square. Plain tile, $30.00 per square. Sixteen ounce copper, 25 cents per foot flat, and with standing seam 27 cents. These prices are governed by the rate of wages of $3.50 for eight hours' work.

Mr. King.—It is the practice on the Union Pacific, generally speaking, to use redwood shingles, and wherever we put on redwood shingles, we paint them with two coats of mineral red paint. A roof of that kind would cost in the neighborhood of $3.25 per square. We get the shingles at $1.90, and they are worth $1.50 at Portland. Our experience is that they are the most satisfactory roofing material that we have used. We have had but little experience with slate. We have used some tin shingles. In this country where there is considerable snow and wind, I find that the wind blows the snow under the tin or slate shingles, forming a drift and it will melt and soak through, loosening the plastering, and for that reason do not think slate does as well as the shingles. Probably nine tenths of the buildings that we have are shingled with cedar or good pine shingles. We then paint them with two coats of mineral red, and find it satisfactory.

Mr. Isaacs.—In California we use shingles of sawed redwood. They cost us $1.75 per thousand, but we have a curious custom in California by which 750 shingles go for a thousand, so that a thousand really cost us $2.30 and about one dollar to lay them. Slate roofs cost $7.00 per square delivered f. o. b. and cost from $3.00 to $3.50 to lay them. Pitch and gravel cost $3.75 per square. We find the slate unsatisfactory in places where we have violent wind; in such places we bed them in plaster mortar. For our pitch and gravel roofs we have been using three-ply material. We sheath with ⅞ by six inch, third quality flooring which we lay on common rafters, 32 inch centres.

Mr. Tanner.—On our road we use all the various kinds of

roofing material. On the shops and engine houses we mostly use four-ply gravel roof, costing about $3.00 per square. It is, as Mr. Cummin says; it depends to a considerable degree how this gravel roof is put on. Most of our roofing of this kind is put on by a standard roofing company of St. Louis who have done most of the work for a number of years. No matter where the work is they go there and are responsible for the completion of the roof. We have but very little trouble with leaky roofs. I find, where we undertake to patch roof of this kind, the action of the cold weather contracts the extra coating of pitch, and then when the thaw comes we have a leak. The kind of roof to be chosen depends upon what kind of a building and what it is to be used for and the amount of money to be expended. In our better class of buildings we use slate and that gives us very little trouble. On our station buildings we use metal shingles and they give good results. We also use cedar shingles, costing about $2.80 per square and about one dollar to put them on.

Mr. Zimmerman.—The roof question has been fairly discussed, but I would like to ask some of the members what specifications they use in putting on a new gravel roof. The felt or paper is numbered according to thickness and weight. What number of felt they would use; how much pitch per square, and how much gravel they would require per square to make a good roof? On our road they use different kinds of material for roofs. The kind of building and the use to which we are going to put it, usually determines the kind of roofing material to be used.

Mr. Tanner.—At one place we have an asbestos roof which has been on about twenty years and gives good results; it costs little above the ordinary gravel roof.

Mr. Sheldon.—With us the cost of a shingle roof is $5.00 to $5.50 per square. Slate, eight to ten cents per foot. Four-ply gravel, $4.00 to $4.50 per square. We have used metal shingles costing from $5.00 to $6.00 laid, but have not had them in use long enough to determine their value.

Mr. Cummin.—We have about twenty metal shingle roofs and have only had trouble with one of them, the others gave

good satisfaction. From one of the best stations on the road I received a communication from the agent stating that the roof was leaking all over. I did not know what to make of it and went out and inspected the roof. I found that the telegraph wires ran about four feet above the roof, and the line men had been tramping all over that roof with their climbers on. It did not take much time to find the trouble that caused the leak.

III. Care of Iron Bridges after Erection.

DISCUSSION.

Mr. Strain.—My idea of the care of an iron span after its erection, is to thoroughly inspect it every three months, at least. The spans should be painted with a good mineral paint every five years. The rollers under the expansion end to be oiled and cleaned once a year. The ties ought to be spaced not over six inches apart, with a guard rail as near the rail as practicable, so that in case of derailment, on a through truss, it would prevent the car striking the side of the span. The rivets should be looked after frequently, and at the first indication of working, they should be removed at once. It is easy to detect a loose rivet, or joint, from the fact that in each defective place, the defect is indicated by a streak of rust. I believe it is good policy to place sheet lead under the end posts. The spans should be adjusted twice a year, in the spring and fall.

Mr. Eilers.—In relation to keeping up an iron span, I think in the first place that the abutments on which the span rests should be kept clean at all times, and in the next place the iron span should be painted once every three years; also adjusted in the spring and in the fall. As far as rollers are concerned we are now putting in box pedestals, which I think are the best, as rollers get full of dirt and then rust, and the bridge slides on the rollers and the rollers move very seldom. We have very little trouble with the rivets and the floor beam connections. Of course the rivets will get loose in the struts, but where they do it is a small matter to remedy it. The most difficulty I find is with the painting. Instead of our own bridge men doing the painting, they generally send men out of the paint shops. Send out a lot of cheap, picked-up men who go right over the bridge without cleaning off the rust, and after it is painted some of the most important places have been neglected. I have found several places where a chunk of coal or a link had dropped down and the painters have gone right along and painted over the link or coal and did not paint the bridge under them.

IV.—How to Determine Size and Capacity of Openings for Waterways.

COMMITTEE REPORT.

To the President and Members of the Association of Railway Superintendents of Bridges and Buildings:

Your committee on the subject "How to determine size and capacity of openings for waterways," present the following report:

In our opinion, the desirable information to collect and compile consisted mainly of the methods actually adopted on railroads to obtain results quickly and in a practical manner, and that the discussion of the theoretical and engineering methods employed would not fall within our sphere, as such questions are usually determined by the engineering department of a railroad. Our aim was, therefore, more particularly to obtain information bearing upon the methods actually used by superintendents and engineers of bridges and buildings in determining the extent to which minor waterways may be reduced on existing lines, as the tendency of the day is to gradually shorten original temporary openings, or to replace trestling by permanent fills, which work usually falls under the maintenance of way departments.

From information collected last year by Mr. Aaron S. Markley, and from additional data obtained by your committee during the current year, it would seem that in actual practice this question is determined in a number of ways, which can, however, in general be classified under the following groups.

1. By personal observation, and information collected on the ground, as to flood height, size of channel, openings in the vicinity carrying the same stream, etc. This general information guides in the final selection of the size of opening, but the actual determination is dependent on practical experience and individual views.

It might be said that, in the main, this seems to be the most usual method, if it can be designated as a method. It is, however, warranted and reliable in flat sections of the country where the bed and contour of a stream at flood times is known or well defined and the current more or less sluggish at all times. It is further probably the best method to pursue in thickly-settled sections of the country where other openings on the same water-course are generally to be found within a very short distance, and satisfactory deductions can be formed from a study of these and from information collected from parties familiar with the territory.

2. Drainage areas are prescribed for different sizes and kinds of openings, the limits for each opening allowing variations to be made according to the local conditions, topography, slopes, soil, rainfall, etc.

This method has many advantages if the table is prepared with reference to a specific section of the country, so that due allowance can be made for the variable rainfall conditions and the prevailing regional characteristics of the territory embraced. It does not eliminate, however, the personal equation in the question, especially as the range of the values in such a table necessarily has to be considerable. It will serve to indicate, so to say, at a glance the general class of opening required, but the final determination will be dependent on individual judgment and a personal examination of the district.

Mr. George J. Bishop (Chicago, Rock Island & Pacific Railway) wrote on April 12, 1897, as follows:

"There are several things to be taken into consideration before deciding the size of culvert pipe or arch required for a permanent opening through a railroad embankment. On the C., R. I. & P. Railway they send out a civil engineer to look up the drainage area of all permanent openings for waterways.

"The first thing to be done is to find the number of acres in the draw to be drained; the height of highest water that has been in the draw, and whether land is cultivated or not; also, if there are small buildings along the draw, that are likely to wash down stream and block up the opening.

"Where the basin is small and has steep banks, and a number of small draws that run in the basin, and where the fill is about 12 feet to 16 feet high, it will require a larger culvert pipe or arch than for a long, narrow draw with a large basin and high embankments, as the water that has fallen by a heavy rain runs off before the water has got to the opening from the upper end of the draw.

"In Kansas, Nebraska, and Eastern Colorado, we allow for drainage as follows, subject to the conditions above:

	Acres. Minimum.	Maximum.
1 line of 16 in. cast-iron culvert pipe,	20	40
1 line of 20 in. cast-iron culvert pipe,	30	60
1 line of 24 in. cast-iron culvert pipe,	45	90
1 line of 30 in. cast-iron culvert pipe,	70	140
1 line of 36 in. cast-iron culvert pipe,	110	220
1 line of 48 in. cast-iron culvert pipe,	180	360
6 ft. arches, 4 ft. side walls,	240	400
8 ft. arches, 4 ft. side walls,	320	550
10 ft. arches, 5 ft. side walls,	500	850
12 ft. arches, 6 ft. side walls,	720	1,300
16 ft. arches, 8 ft. side walls,	1,280	2,300

3. Determination of the area to be drained and of the general characteristics of the country, soil, and stream, which information is used in connection with an empirical formula giving the area of waterway required, based upon the drainage area with variable coefficients to suit the different conditions.

In regard to this method, it can be said that the use of a "formula," even if an empirical one, casts a certain amount of scientific glamour around the question that, in many cases, may seem to enhance its value. As all such formulas have variable coefficients, it is evident that individual views and personal examination of the characteristics of the watershed and stream will have to govern largely in the final determination. Such formulas have the great merit, however, of serving as a guide to determine quickly the general range of the probable minimum, maximum and average values, and, therefore, can be classed as practicable and serviceable, especially when the range of the coefficients for the various climatic and local conditions has been properly predetermined.

Considering the allowances that have to be made anyhow for greater safety, especially so as to provide, more or less, for cloudbursts and unusual contingencies, it can be said that for all minor openings an empirical formula suitably applied and not taken too strictly, supplemented by personal examination of the territory, practical experience and sound judgment, will give as good practical results as minute and careful engineering surveys and theoretical calculations.

Probably the best-known empirical formula for determining directly

the proper area of a waterway and one that has been used most extensively in American railroad practice was advanced many years ago by Mr. E. T. D. Myers, president, Richmond, Fredericksburg & Potomac Railroad, namely:

$$\text{Area of waterway in square feet} = C \times \sqrt{\text{Drainage area in acres}}$$

where C is a variable coefficient. For comparatively flat ground or slightly rolling prairie, C is generally assumed as 1; for hilly ground as about 1.5; and for mountainous and rocky ground as high as 4. In exceptional cases even much higher values have been found to be necessary to correspond to the actual quantity of water as gauged at flood times.

In regard to the proper values for the coefficient, Mr. Myers states (see his letter of August 3, 1897, quoted in full in the Appendix to this report): "The coefficient should be derived from careful and judicious gaugings at characteristic points within the region under treatment, and applied by a liberal hand."

It is generally claimed that this formula gives too large openings for very small drainage areas. Possibly this might be considered an advantage, as very small openings should never be made equal to the theoretical results, but ought to be made larger for practical reasons. Hence the formula in this respect certainly corresponds with practice if not with theory.

Another statement made against this formula is that it gives too small values for very large openings. It has generally been understood that Mr. Myers intended this formula to apply to minor openings on railroads and not to important streams. For the latter there is no question that a more careful study of the conditions and environments is absolutely necessary, and the sole use of an empirical formula in connection with a coefficient established by snap judgment in the office or a hurried trip over the ground is entirely out of place.

A formula advanced by Professor A. N. Talbot (Selected Papers of the Civil Engineers' Club of the University of Illinois) and stated by him to be "more as a guide to the judgment than as a working rule," is as follows:

$$\text{Area of waterway in square feet} = C \times \sqrt[4]{\text{Cube of drainage area in acres}}$$

in which C is a variable coefficient. "For steep and rocky ground, C varies from 2-3 to 1. For rolling agricultural country subject to floods at times of melting snow, and with the length of valley three or four times its width, C is about 1-3; and if the stream is longer in proportion to the area, decrease C. In districts not affected by accumulated snow, and where the length of the valley is several times the width, 1-5 or 1-6, or even less, may be used. C should be increased for steep side slopes, especially if the upper part of the valley has a much greater fall than the channel at the culvert."

Professor Ira O. Baker, University of Illinois, in his book on "Masonry Construction," says, in regard to Myers' formula, that for small drainage areas it gives the area of waterway too great and for large drainage areas too small. In regard to Talbot's formula, he says that he had tested it and found it agreed fairly well with the experience of fifteen to twenty years, and that, in these tests, it was found that waterways proportioned by this formula will probably be slightly flooded, and consequently be compelled to discharge under a small head, once every four or five years.

Our deceased member, Mr. L. K. Spafford (Kansas City, Fort Scott

& Memphis Railroad), made use of Myers' formula with a coefficient from 1 to 3. He wrote on July 18, 1896:

"We have no iron-clad rules for deciding such matters, but usually, when the question of an opening arises, have a survey made, showing the area, and then make the opening from one to three times the square root of acres drained, the size of the opening depending on the topography of the ground. If the ground is level, we would probably use twice the square root of the acres drained. If the ground is hilly, we would use three times the square root of the acres drained."

Our deceased member, Mr. R. M. Peck (Missouri Pacific Railway and St. Louis, Iron Mountain & Southern Railway), wrote on June 11, 1896:

"We determine the size of openings by a careful survey of the area of land to be drained. There is a great deal depends upon the natural lay of the land to be drained. If the country is very mountainous, and slopes of hills or mountains are steep and abrupt, we figure that one foot of area will drain four acres of land. Where the lay of the land is ordinarily flat and rolling, such as is found in good agricultural countries, we figure that one foot of area will drain six acres of land. These are the two extremes. We hardly ever go above or below these figures, but use all sizes between them, as the different and peculiar locations may demand."

This expressed in a formula would be:

$$\text{Area of waterway in square feet} = \frac{\text{Drainage area in acres}}{C}$$

where C varies from 4 to 6.

4. Careful surveys of drainage area, slopes, gradients, and cross sections of stream, determination of velocity of flow by observations or calculations, application of hydraulic formula to flow of water through various-shaped openings under different heads, at different stages of the water height, determination of probable average and maximum rainfall, the volume of water and the time within which it will reach the opening, etc.; from all of which information the shape and size of the opening is determined so as to carry off the water quickly, and without scouring the bottom of the stream, or injuring the structure.

After a careful consideration of the question, your committee decided, as stated above, that it would not be advisable to enter into a detailed discussion of this branch of the subject.

In many instances certain data, such as the drainage area, the gradient and cross-section of stream, and the probable maximum flood height and velocity, can be ascertained very readily and sufficiently accurate for all practical purposes, and will throw considerable light on the question when such data are applied to elementary hydraulic formulas, or, more usually, deductions are drawn by ordinary arithmetical methods and reasoning.

For large and important openings and wherever careful research is desired, the proper investigation along the lines indicated above involves much detail study and field work by engineers. But even with the best talent and mathematical demonstrations brought to bear on the question, it will inevitably be finally settled largely on the basis of expert practical knowledge, as all the controlling formulas are dependent in the first instance on assumptions and finally on the proper choice of variable coefficients. Thus assumptions have to be made as to the probable maximum rainfall and the proportion of it reaching the waterway within a given period of time; the evaporation, absorp-

tion and percolation of the water on its way to the opening; the greatest allowable velocity at the bottom of the stream so as not to scour the bed; the greatest allowable velocity or pressure so as not to damage a structure discharging under a head of water dammed up by the railroad embankment; etc.

There are numerous formulas for the amount of water reaching a certain point of a water course, known by the names of their authors, as the Fanning, Craig, Dredge, Dickens, McComb, McMath, O'Connell, Hawksley, Adams, Buerkli-Ziegler, Kirkwood, etc. Most of them are quite complicated, and when applied to a given case it will be found that the results all differ, more or less, from each other, and will only serve for general guidance, unless the tests and conditions governing a particular formula are known to be in the main similar to the case under treatment. Further, the theory of the flow of water in open channels (leading to the embankment) and in closed conduits (passing under the embankment) is largely conjectural and dependent on actual tests and gaugings under conditions frequently entirely different from those under consideration.

All these features, therefore, emphasize the difficulties of the task and the necessity of employing specially-trained engineers or expert hydraulicians for all important work of this kind, as the true value of the application of "theory" to this problem is directly proportional to the correctness of assumptions borrowed from "practice." In the hands of a practical and experienced adept, the data bearing on the case, consisting of part theory, part assumptions, and part observed facts, will be molded into fairly good shape and some tangible and valuable results obtained.

In conclusion, it will be desirable to state that a uniform and practical solution of the question, "How to determine size and capacity of openings for waterways," cannot be formulated, owing to the great variation in climatic and local conditions connected with this subject. It will remain, more or less, dependent on information collected in examining the particular territory, observations, or gaugings and tests made under similar conditions, personal experience, individual views, and practical judgment.

Particular emphasis should be made of the fact that a very general opinion seems to prevail, that openings should in all cases be made ample and large enough for all contingencies, erring always on the safe side, as the possible damages and subsequent expenses connected with inadequate openings far exceed the small extra first cost of a slightly larger waterway. It is probably not practical to say that it is feasible to provide absolutely in all cases against every possible contingency of the future, and there is, naturally, a reasonable limit, even admitting the logic of the above argument. Reduced first cost, when placed in the balance with future savings, may frequently prove to be the heaviest consideration, even with the possible attendant danger to life in case of a washout. This feature of the question is largely dependent on the policy outlined by the management of a railroad. It is naturally correct to aim to make the structure just as safe as possible, considering all the governing conditions.

There is one additional feature that should receive mention, namely, the fact that the crude methods of construction adopted for openings are frequently more at fault than the insufficiency of the waterway area. The capacity of an opening is not only dependent on the actual area and shape of its cross-section, but also on the permissible pressure under a dammed-up head of water, or the velocity of flow that is allowable without damaging or disrupting the structure, scouring the bed, or working through the embankment. A closed culvert, discharging under the pressure caused by the water level being raised above the

top of the opening, ceases to be a mere covered channel, and becomes a pipe, with bursting pressures proportional to the water head. In all such cases, where it is known that the flood height will be above the opening, it certainly seems desirable to build larger openings, or else a better class of structure, able to withstand the bursting pressure and the increased velocity of flow. The construction of the ends of waterway structures, the channel approach and run-off, the bed, and the material in the embankment exposed to the scour and wash, should all receive close attention in important and critical cases.

We append several valuable independent statements on this subject, and also typical extracts from a number of the letters received in pursuing our investigations.

We also present an engraving, showing the average annual rainfall in different sections of the United States, the original cut having been published in *Engineering News*.

WALTER G. BERG,
AARON S. MARKLEY,
ONWARD BATES,
A. J. KELLEY,
Committee.

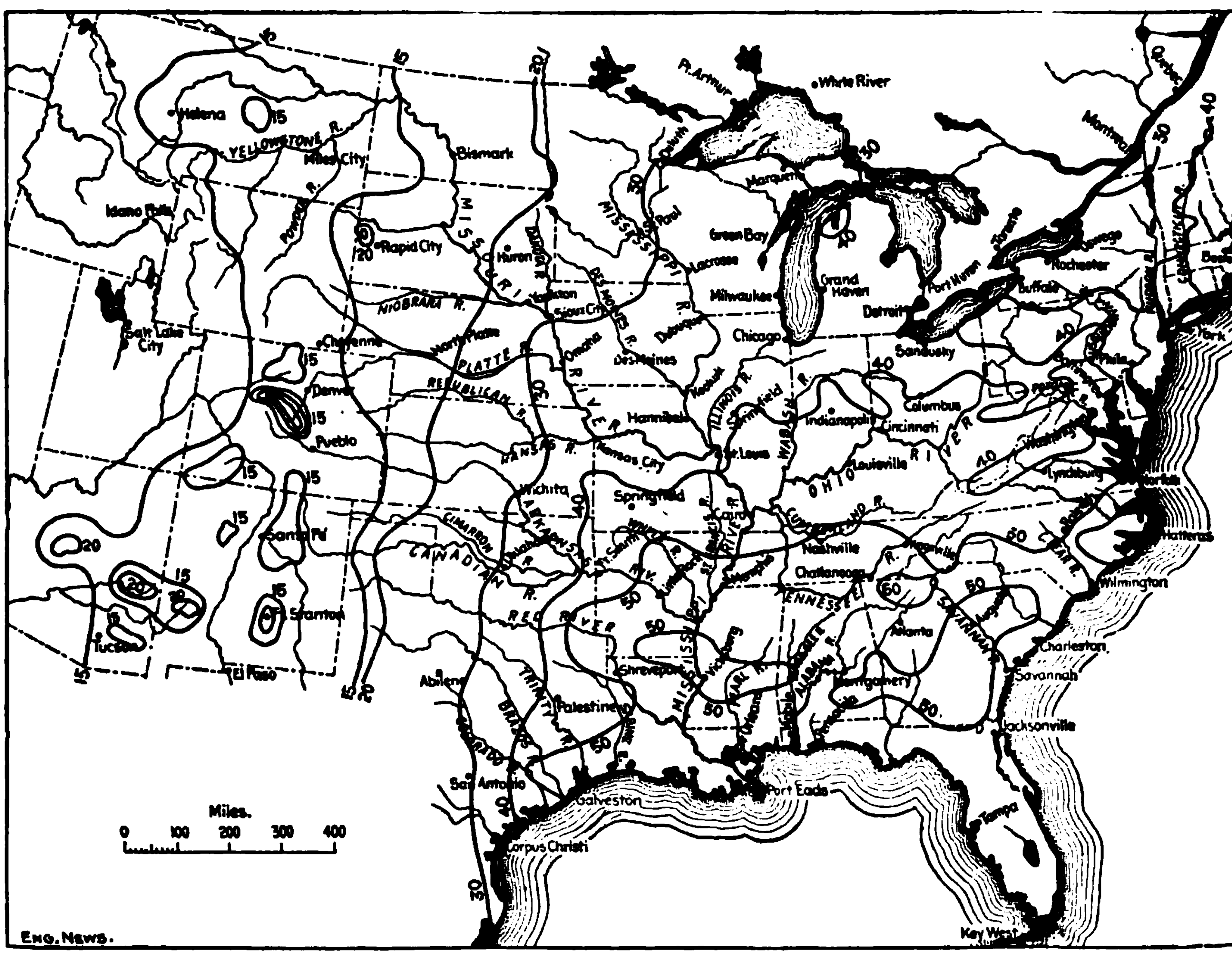


FIG. 1.—AVERAGE ANNUAL RAINFALL OF THE UNITED STATES.
Figures show total depth in inches.
[Plate kindly furnished by *Engineering News*.]

APPENDIX TO REPORT OF COMMITTEE ON THE SUBJECT, "HOW TO DETERMINE SIZE AND CAPACITY OF OPENINGS FOR WATERWAYS."

STATEMENT OF MR. AARON S. MARKLEY, CHICAGO & EASTERN ILLINOIS RAILROAD, DANVILLE, ILL.

The gauging of waterways under embankments requires a man of good judgment, familiar with the nature of the country, as well as the streams and the source of supply, together with the character of the soil and climate.

The most accurate and economical manner of determining this is to keep a record of highest water in streams at all times when rainfall is extraordinary, and calculate the required size of the opening from the area of flow of water at that time. This can be checked by the number of acres drained.

The more familiar a man is with the territory drained, the more capable is he to judge the capacity of the opening required. Rules that are applied to one section of the country for this purpose cannot be applied to all sections. In many instances, an opening which is sufficient for a given area in one section will not be sufficient in another section, the conditions of surface and character of soil being different. For instance, where banks of a stream are low, it will necessarily take a wide opening to avoid backing water up over adjoining land; where banks are high, a higher opening and not so wide may be placed. This is the case more particularly in iron pipes; where banks are high, a 60″ pipe will answer, but if banks were low, two smaller ones having the same area should be used. A most serious objection, however, to a double line of pipe over a single line is, that any accumulation of drift will pass through the latter more readily, making it less liable to clog up.

To avoid as much as possible the overflow of land, it is preferable to make openings of all classes as wide as possible, so that full flow of opening can be had without damage to abutting property.

In a territory where the ground becomes frozen, or is of such a character as not to be easily penetrated by the water as it falls, a larger opening must be provided than at such places where the water is absorbed quickly and comes to the opening slowly.

Following are notes showing the sizes of, and the area drained by, several openings which have been known to the writer from personal observation since the present openings have been put in, namely, from six to ten years ago. These openings were selected from several hundred along the line of road, in order to get those that were known to do all the work they could do and at the same time not overflow the adjoining land. The area drained by these openings has been surveyed under the direction of Mr. W. S. Dawley, chief engineer C. & E. I. R. R.

One 12-inch pipe drains an area of 12 acres, the main channel of which is 400 feet long and has an average fall of 5 feet in 100.

No. 1186. A 24-inch pipe drains an area of 50 acres; main channel 1,300 feet long, with an average fall of 3¼ feet in 100.

No. 1088. A 36-inch pipe drains an area of 125 acres; main channel 3,500 feet long, with an average fall of 9-10 of one foot in 100.

No. 1219. A 36-inch pipe drains 170 acres; main channel 3,548 feet long, with an average fall of 1 4-10 feet in 100.

No. A, 1307. A 60-inch pipe drains 110 acres; length of main stream 3,600 feet, with an average fall of 2 2-10 feet in 100.

No. 1255. A 14-foot stone arch drains a stream known as Lick Creek, near Danville, Ill. The accompanying illustrations show the cross-section of the arch and the topographical survey of the drainage area. A very careful survey was made of the main channel, tributaries, and land drained by this stream, and the drainage area consists of 3,560 acres, the main channel being 4¼ miles long and one tributary 1¾ miles long, with an average fall of 29 9-10 feet per mile. This arch was completed and bank put on it in 1881. In 1889, the water was three feet above the crown of the arch for about three hours, the only time since it was built that it has backed up over the adjoining land to do any damage. At this time, the land owner brought suit for damage to crops, but the court held, in its decision, that the railroad company was not obliged to provide openings for waterspouts, as this case was decided to be. Suit was decided in favor of the defendant.

Having known this stream and observed its nature through all storms since the arch was built, I am familiar with its history, as well as the iron pipes referred to. Nearly all the land in this country is well tilled, and as a rule not very hilly. Being well tilled, the water finds its way to the main channel very readily, which makes some difference in the size of opening required.

It is my practice to note the stage of the water in as many streams as possible after all very unusual rainfalls, and to note the flow of water through the openings of all kinds, and if anything out of the ordinary, I note it in the last annual inspection book. When a wooden is to be replaced by a permanent structure, these records are referred to, and size of opening to be used decided upon in many cases. If no record exists, capacity of waterway is judged by what other waterways are doing under similar circumstances. What one opening will do, another one similarly situated, and the conditions being the same, will certainly do. I very rarely try to get information from the land owners, as their knowledge of the flow of water through opening is very limited, and the height of the water, as a rule, very much exaggerated. Openings under highways or private roadways sometimes are a practical guide, but in many cases banks are low each side of opening, so that water overflows roadway, which fact destroys any reliable information from that source.

NOTE.—The 14-foot arch, No. 1255, referred to above, has a waterway area of 142 square feet. It is 13' 10'' wide at the spring-line of the arch, and 12' 11' wide at the foot of the side walls. The centre of the arch is dropped 1 foot below the spring-line. The side walls are 5' 6'' high, and built with a batter of 1 to 12. The paving is dished 8'' at the middle of the opening.

Statement of Mr. Onward Bates, Chicago, Milwaukee & St. Paul Railroad, Chicago, Ill.:

"I will not assume to give a rule for the proper determination of waterway openings under tracks, but will explain this company's practice. Waterways on new lines are determined by the engineering department, and I assume that waterways which the Superintendents of Bridges and Buildings are interested in are those which come in problems of renewal, usually of wooden bridges with permanent work. These are the problems which are met on this road, and we endeavor to solve them in the following manner:

"Track men are instructed to record high-water marks at all bridge openings, and as they have, ordinarily, at least eight or ten years' experience with the bridges before renewal for the first time, they should have definite information about high-water marks. After unusual floods, particular care is taken to ascertain high-water marks, both by track men and by employés of the bridge department. These

high-water marks are entered in our office bridge books for reference when the bridges are to be renewed.

"Six months before the proposed renewal of bridges, lists of such as are to be renewed are furnished to the chief engineer and division superintendents. The chief engineer has an assistant engineer make a report, giving his recommendations for permanent openings. The assistant engineer takes into consideration the high-water marks, area, and slope of watershed, amount of rainfall, etc., and reports the area of waterway which he considers necessary at each bridge.

"The division superintendent makes a similar report, based on his own knowledge, as well as information which he obtains through the road masters and section foremen.

"The bridge inspectors make a third report, based on all of the information which they have access to. These three reports are compared, and the final area of opening decided by the chief engineer. If a study of the reports leaves doubts as to the recommendations, special surveys are ordered, and in some cases special trips are taken by the chief engineer and the question decided on the ground.

"Conditions are so variable that a formula for technically determining waterways will at best be nothing more than a rough check on a decision which is based on experience and judgment. By systematic observation and record of waterway requirements extending over the life of a wooden structure, we are enabled to arrive at a more rational determination of waterways than can be accomplished by an arbitrary formula. We have within the last ten years replaced thirty-five miles of wooden bridges with iron structures and embankments with satisfactory results as to size of waterways retained."

Statement of Mr. A. J. Kelley, Kansas City Belt Railway, Kansas City, Mo.:

"Our practice has been to first ascertain the volume and velocity of water. This information can be obtained only by personal observations collected during heavy rainfalls. A very good rule and one that we have found to work well in determining the flood height is, that in case of storms the bridge foreman must be on duty and see that bridges and culverts are not being damaged by storms, and to make permanent high-water marks at all openings that are liable to be damaged by high water, also to note the velocity in feet per second. Having the flood height and velocity, it is an easy matter to determine the volume of water to be taken care of. I have one ten bent pile trestle 135 feet long and 24 feet high over a spring branch that ordinarily runs about six cubic inches per second. Last summer, during one of our heavy rain storms (four inches in less than three hours), I visited this place and found by float observations the surface velocity at the highest stage to be 1.9 feet per second. I made a high-water mark, and after the flood water receded found the width of stream to be 12 feet and an average depth of 2¼ feet. This, with a surface velocity of 1.9 feet per second, would give approximately a discharge of 50 cubic feet, or 375 gallons, per second. Having this information, it is easy to determine size of opening required."

Statement of Mr. J. P. Snow, Boston & Maine Railroad, Boston, Mass.:

"The present practice on the Boston & Maine Railroad in determining the size of waterways, large and small, is wholly by observation, governed by the evidence furnished by other openings on the same stream and by parties acquainted with the locality. The marks left

by the streams at each spring freshet, coupled with the knowledge of residents as to the comparative heights of maximum floods, is a sufficient guide in case of actual streams.

"For small drains, the almost universal structure with us, where there is sufficient height of fill, is the stone box culvert. There is nothing saved in making these less than three feet square, and this size is sufficient for all places where there is no actual stream to guide one, as above, to a correct estimate of the size of opening required. Many Akron pipes from 12 to 24 inches have been laid, and a few cast-iron pipes up to 48 inches diameter. The excellent quality of granite found all over our territory permits us to use stone covering up to 8 and 10 foot span in some cases. Personally, however, I would limit its use to 6 feet clear opening. The regular quarry size of stone with us is 2 foot rise; these make excellent covers for culverts of not more than 6 foot span.

"Formulas may be useful to one wholly unacquainted with similar work and in case of disputes with land owners, etc., but the large range of the coefficient to be used throws the result back on personal judgment, the same as if no formula were used. The two formulas, Myers' and Talbot's, given on page 394 of Baker's "Masonry Construction," are as good as any that I know of.

"The possibilities of drift material must be considered in designing a culvert; double box culverts or two lines of pipes are objectionable where drift is to be expected. Where pipe culverts take the water from low-lying farm land, they must be placed low or there may be a claim that the water is set back, because the bottom of the pipe is not so wide as the natural stream. On account of this restricted flow, unless the water is raised to some height, I prefer a square, stone culvert in many localities to large pipe.

"For large streams, our system covers conditions varying all the way from tidal streams along the coast to torrent-carrying ravines in the White mountains. A tidal estuary may generally be safely narrowed considerably from the extreme water lines, if stone revetments are used to protect the bank from wash. Above the true estuary, where the stream cuts through the marsh, we generally find nearly vertical banks, and we are safe if the faces of abutments are placed even with the banks.

"In level sections of the country, where the current is sluggish, it is usually safe to encroach somewhat on the general width of the stream, but in rapid streams among the hills the width that the stream has cut for itself through the soil should not be lessened, and in ravines carrying mountain torrents the openings must be left very much larger than the ordinary appearance of the banks of the stream would seem to make necessary. In rebuilding old bridges, our general practice is to shorten them. The temptation is strong to build the new masonry inside the old, and in the majority of cases I think it is safe. We must, however, be sure of our foundation. First-class masonry will stand almost anything from water except undermining. Piles should be used wherever they can be driven. In a rapid stream with a rocky bottom, where it is impossible to drive piles, paved as many are in New England with rocks and boulders of all sizes tightly packed by the water, I think it safer to build on these packed stones without disturbing them rather than to excavate for the purpose of starting the wall below the river bed. Of course we must remove the loose stone and get a fairly level bed, but if we excavate to any depth we are bound to loosen the naturally-packed stones immediately in front of our new work and to leave a furrow of loose filling at this vital point. If we have no serious freshets for two or three years, the stream may repack this furrow in an unscourable manner, but if a

severe flood occurs the season following the reconstruction, there is great probability that the water will find the soft spot and make an excavation that will cause chagrin to all parties interested.

"This digression on foundations is somewhat off the question, but the spectacle of a piece of first-class masonry undermined and ruined within twelve months of its completion has taught me that the character of the stream bed is as much a function of the waterway required as the span of the structure, and that the ground in front of the abutment needs as critical attention as that under it.

"No fixed rule depending on the acreage drained and the annual rainfall can be safely used in all parts of the country alike for determining the proper size of waterways. The judgment of a man acquainted with the region and the character of the ground should be obtained, but if the duty of designing the opening falls to a man not equipped with this knowledge, his only safe course is to leave openings surely large enough."

EXTRACTS FROM LETTERS RECEIVED BY THE COMMITTEE.

Mr. E. T. D. Myers, president, Richmond, Fredericksburg & Potomac R. R., Richmond, Va., author of "Myers' Empirical Formula for Area of Waterways," kindly forwarded, on August 3, 1897, the following remarks to the committe:

"The committee's circular (see Sec. 4) renders it unnecessary to say anything more on the subject of the formula suggested by me a good many years ago, than that the coefficient should be derived from careful and judicious gaugings at characteristic points within the region under treatment, and applied by a liberal hand. Upon a line already constructed and cared for by an intelligent engineer, no formula can furnish so safe a guide or should take precedence of his own observation and experience; but neither with a formula, however wisely constructed, nor with information based upon the most careful observations over the period of a generation, can we be assured that we have provided, so far as area goes, sufficiently against cataclysms, against which it might be assumed that it is impossible to guard. While to a certain extent such an assumption may be warranted, it must be remembered that great lines of aqueduct to large cities must be proof against the extremest conditions to which they are subject; and yet many of these aqueducts are exposed to the vicissitudes of the weather equally with works like railways and canals of navigation. A 'washout' on a railway or a 'break' in a canal is a serious matter, but insignificant, of course, when compared with a 'water famine.'

"I think the engineers of aqueducts have, to a marvelous degree, succeeded in so constructing them as to be safe against interruptions from flood. Of course great care is bestowed upon the dimensions of their drainage works, and that which under ordinary circumstances might be considered extravagant, is in their case justifiable. Yet I am not satisfied that it is to this cause alone, or even to this cause chiefly, that their success is due. I am persuaded that it is rather in the superior construction, the infinite painstaking to insure the safety of a culvert when it ceases to be a mere covered channel and becomes a pipe discharging under pressure. When this takes place, the ordinary culvert is too apt to fail to do its duty. Between the hastily constructed dry stone box and the thoroughly-built concrete, brick, or stone culvert, there is room for a legion of catastrophes. I am not prepared to argue that the construction of the less important works of the railway should rank either in execution or cost with those of

the Croton, or the Washington, or the Baltimore aqueducts, for instance, but I am nevertheless of the opinion that it is more often the crude method of construction than the underestimation of the area of the waterway that gives us trouble on the railroads. When a railway embankment is called upon to act as a dam, as it may be in great floods, it should possess the qualities of a dam, and the outlet from the piled-up waters above it should possess the same integrity as the drainage culvert of a reservoir. Its foundations should be as secure, its masonry as impervious, the embankment immediately surrounding it as free of voids, the inlets and outlets as carefully protected from abrasion.

"Of course many pages have been and might be written as to the manner of securing such an end. Having had some experience both on railways and aqueducts, I have decided opinions on the subject of the masonry constructions on each, but I am warned to embody my views briefly in connection with the committee's report, and you will no doubt thank me for refraining from further elaboration."

Mr. Clemens Herschel, engineer, water department, Lehigh Valley R. R., No. 2 Wall Street, New York, N. Y., has kindly contributed the following information:

"I have read the committee circular of the Association of Railway Superintendents of Bridges and Buildings, with a great deal of interest. There is very little that I can add to the remarks of the able and careful men, printed in the committee circular. One case I remember in Massachusetts, in which a railroad was condemned to pay some $95,000 damages, caused by a simple box culvert, some three feet square, connecting two ponds. The consequence was, that on account of the small velocity ordinarily obtaining through this culvert, it gradually, in the course of some thirty years, filled up; being out of sight, submerged, it was out of mind; so that one fine day, when, on account of melting snow, there was a very large inflow of water into the upper pond, the culvert was too small to maintain the level of the two ponds at practically the same height. As a still further consequence, the up-stream pond rose so rapidly that it overtopped a small subsidiary dam of the upper pond a mile or more up stream from the culvert, and caused a washout through the natural hills, something like seventy or eighty feet deep. This happened near Clinton, Mass., early in the '70's, on the road running from Clinton to Worcester. The moral is, that submerged culverts are bad things, as they are out of sight and out of mind, and are liable to silt up in course of time.

"I had to go all the way to Russia to learn a cheap way of preventing culverts from clogging up with drift-ice and driftwood. This is done by driving a row of small piles in a semicircle up stream from the up-stream end of the culvert, using a radius of about twice the width of the culvert, and with intervals between the piles of about ten inches or a foot. This makes a coarse kind of a rack in a semicircle up stream from the culvert, which neither ice nor driftwood in any harmful quantity is liable to pass by, going through or over."

W. M. Noon, Duluth, South Shore & Atlantic Railway, Marquette, Mich.:

"I watch from year to year, and note the flow of water during freshets."

W. O. Eggleston, Chicago & Erie R. R., Huntington, Ind.:

"My experience is to watch the streams and rivers at their highest flood. This you can see nearly every year, and, by asking some old resident, an idea can be formed of size of opening required, of course allowing some for excessive floods. This has been my experience, and my judgment in this matter has never failed yet."

N. W. Thompson, Pennsylvania Company, Fort Wayne, Ind.:

"It has been our custom to rely upon observation of the conditions at each particular point for determining the size of opening required. In case of doubt, or in the construction of new lines, we usually employ methods given by 'Trautwine's Engineers' Pocket Book.'"

C. C. Mallard, Southern Pacific Railway, Algiers, La.:

"In this part of the country, except in cases where the levees break and we have to provide for floods from the Mississippi, the subject is one which bothers us but very little. The streams we cross have little or no current, and in providing openings for the plantations we know that if they are a trifle larger than their drainage ditches and canals there can be no trouble."

William Carmichael, Union Pacific R. R., Junction City, Kan.:

"It is my opinion, that the only safe way to determine the size and capacity of waterways, is to look the ground over carefully and ascertain the possible number of acres of land the opening will have to drain. The nature of the soil should also be taken into consideration. If the opening is located where the soil would not take up any of the rainfall, the opening would necessarily have to be larger. I think where this plan is followed, and the parties do not figure too closely on the amount of rainfall, that the size of the opening can be easily gotten at. If one is in doubt as to the size of the opening, he should always give the opening the benefit of the doubt. The cost of building the opening large enough is very little, compared with the cost of washouts and a possible wreck."

M. F. Potter, Cleveland, Cincinnati, Chicago & St. Louis Railway, Franklin, O.:

"Mr. Wm. Carmichael's report on the subject, is, in my judgment, as good a method as one can adopt in determining the size of opening required for waterways. Different localities, of course, require different calculations; but the method mentioned, together with a little common sense, will accomplish, I think, what is required, as near as any calculation that can be made. It is the method I have used for over twenty years, and have always had good success."

E. F. Reynolds, Chicago & Northwestern Railway, Ashland, Wis.:

"The question of sufficient waterway is a hard one to solve, and under most favorable conditions is nothing but guesswork on the part of Superintendent of Bridges and Buildings, as we do not have the proper instruments to thoroughly survey the thoroughfares and sometimes we have to put in openings very quickly. I can only say that I would surely compute the amount of water that has to my knowledge passed through, and would of course take into considera-

tion any information I might gather from responsible parties; also would take into consideration in a timbered country the fact that there would be an increase of water after timber is cut off. I would then make my opening at least to carry twice the amount of water computed, taking everything into consideration."

S. F. Patterson, Boston & Maine R. R., Concord, N. H.:

"A good way in building new is to consult the people living in the vicinity, look up high-water marks, etc.; and in case of old structures, watch them and see if the openings carry off the water all right, and if not, enlarge them."

W. B. Yerance, West Shore R. R., Weehawken, N. J.:

"Generally speaking, I would not depart from my more expensive yet economical practice of 'providing sufficient.' In the solution of this problem, as in many others, there is but one side on which a mistake may be made—avoid all possibility of a mistake. It is much cheaper in the long run to decide upon the 48-inch pipe when the question seems to be as between that size and a 30-inch—though the subsequent cost of repairing the bank may be hidden in the labor account and not observed by the officers authorizing all expenditures. I do not consider it is possible to formulate any general rule that will satisfactorily cover all cases. I believe, with Mr. N. W. Thompson, that each case must be treated in the light of its own conditions."

H. L. Fry, Cape Fear & Yadkin Valley Railway, Greensborough, N. C.:

"We determine the size of openings by careful examination of the country to be drained, and by accurate measurement of flood area of streams."

George W. Andrews, Baltimore & Ohio Railroad, Wilmington, Del.:

"I do not believe any empirical method or formula can be successfully adopted for determining size of small waterways, as we seldom find two precisely the same. In my judgment, the best method is to make a careful survey of the property to be drained, number of acres, and condition of soil; then put in pipe or box culvert sufficiently large to carry off the natural drainage, with a margin of safety for heavy rainfall."

J. H. Markley, Toledo, Peoria & Western Railway, Peoria, Ill.:

"I have piped for my company 281 bridges with pipe ranging from 20 inches up to 7 feet. Out of this number of bridges piped I underestimated but two. I estimated the capacity of the pipe wanted by personal observation. I always make it a point to get over the line as soon as possible after very heavy freshets. I often can estimate the size wanted by an old opening in a public road either above or below the bridge in question. Surveying the drainage area is no doubt a good way to get at the capacity of the outlet. This, I claim, cannot be done unless the engineer is thoroughly acquainted with the soil. For instance, on the line of this road there is a tract of seventy-five acres that drains towards the road with no outlet. Two miles west of this the same number of acres require a 4-foot pipe to carry the water."

A. Shane. Cleveland, Cincinnati, Chicago & St. Louis Railway, Lafayette, Ind.:

"In reply to the question, 'How to determine size of waterways' I am tempted to assert that it is largely conjectural. One may, however, arrive at something near the size of an opening necessary, if he be familiar with the locality, and by taking a survey of the area drained, considering the chorography and the average rainfall, the rapidity with which the water may come together, and the volume when assembled to be provided for; that it is necessary for one to be familiar with the locality, is shown by a comparison of rainfall in different sections, for instance, for the year ending August 31, 1894, the average was in Maine from 42.1 to 50.1; in New Hampshire it was 41.9; in Vermont it was but 28.8, and in Connecticut it was from 49 to 50. In Pennsylvania, Ohio, and Virginia, there was not a great deal of difference, ranging from 31 to 52, but in Iowa the average was from 36.4 to 37.3, while in Kansas it was, in some sections, but 20, the general average being but 36 inches in the United States. At Port Said the rainfall for the same year was but two inches, while at Chirpongee it was 610.

"Although we have reliable data of rainfall in the past, they give us no definite knowledge of possible ones of the future. When we consider the disturbing effects of the works of progressive science upon the laws of nature, causing storms to be more local than general, and the facility with which water may pass off, owing to improvement constantly being made, it seems impossible for one to compute, with any degree of certainty, the volume or velocity with which water may pass away. But, should one be able to calculate the maximum of quantity and the minimum of time, and then determine upon the size of an opening required, there are other things; for instance, a waterway may be obstructed, a thing liable to occur at any time, and over which one has no control, having no jurisdiction over territory drained, and being unable to prevent the accumulation of debris. For this reason, I think the greatest care should be taken in putting in small openings, such as tile, pipe or box culverts, and judgment used as to whether they be adapted at all in some sections of the country. For, if a considerable area is to be drained, and the land be rolling, it is questionable whether such waterway be used at all, for one can have no assurance that it will not make trouble at some time. I think it well, in constructing a road or putting in a new opening, to be sure to get it large enough, and let time and experience determine whether it may be reduced without endangering the road-bed and damaging property above and adjacent to the railroad by backing up the water, and overflowing the land, or perhaps changing its course. There seems to be a tendency toward an indiscriminate use of pipe culverts, thus jeopardizing the safety of trains, as was evidenced recently by several such openings either being washed out, or the road-bed in the immediate vicinity being damaged."

V. Designs for Ice-Houses.

REPORT OF COMMITTEE.

To the Officers and Members of the Association of Railway Superintendents of Bridges and Buildings.

Gentlemen:—Your committee appointed to report on the subject, "Designs for Ice-houses," feel that their work would be but begun were we to present as our report merely a collation of designs showing ice-houses, either proposed or constructed. We therefore beg your indulgence in a rather fuller discussion of the subject than the mere title of this report would suggest.

As the necessity for one or more ice-houses for railroad purposes presupposes the use of ice by the carrier, it seems desirable at the very outset to give some consideration to the question from the standpoint of the traffic and transportation departments. Let us consider, therefore, (1) for what purposes, in what quantities, and where ice is needed; (2) how it is proposed to obtain it, and how delivered to the house; and (3) how distributed to meet the needs. This information must be given in order that the subsequent designs shall meet, as nearly as possible, the requirements, without necessitating too great an outlay, and permit of handling the ice at the lowest possible cost for labor, and the smallest percentage of waste or loss.

The ice may be used in refrigerator and dining car service, station, office, and coach water coolers, and station and coach urinals; the quantities of ice used for each purpose vary widely on different roads. The point or points where the ice is needed is determined by the transportation and traffic departments, usually to best serve the needs of the refrigerator car service.

The supply may be obtained by manufacture, by cutting from ponds, etc., in season, and storing the entire year's supply, or from contractors as needed. It may be brought to the storehouse on endless belt, wagons, cars, or boats.

The distribution is usually made from large or main storage houses by periodical shipments in box or refrigerator cars, to points of minor distribution—infrequently in baggage-cars of passenger trains, though in the latter case, of course, with much loss.

The location of the ice-house is practically independent of the location of the proposed source of supply; the need of a large storage house becomes apparent only when the use of natural ice in considerable quantities is contemplated, and at the time the crop is harvested the temperature (in the central and northern parts of the country) will be so low that the ice can be hauled long distances, if necessary, with slight loss, the main part of which will be from breakage of the cakes.

But your committee feels that attention has not been sufficiently directed to the manufacture of its own ice by the road needing a supply. While on Southern roads especially such a proposition would in many cases be most forcibly presented by the traffic department in the light of the influence of a sufficient supply of ice in controlling, or even handling the dressed meat, dairy and fruit trade, it still devolves upon the engineer to prepare estimates of cost as between the two plans.

The cost of the natural ice supplied will vary so much in different localities that it is impossible to take any figure as an average cost to cover the case generally. Where in one case it may be 50 cents per ton put in the house, in another house on the same road the cost may run up to $1.25 or more in the house, and that although the different

contracts were all placed at the same time, prior to or during the winter season. At other times of the year, of course, prices run much higher. Until the stock is actually housed there is in this latitude much cause for worry whether a full supply can be secured at any reasonable price. The demand for ice varies much as between different years, the main causes therefor being differences in severity of seasons and fluctuations in volume of refrigerator-car business handled. Of course, a full supply must be stored during the cold season, but in the event of but little ice being used during the ensuing year, a heavy loss is entailed. The shrinkage of such a stock we have known to amount to about 55 per cent of the total.

With the manufacture of its own ice the road is independent of the season, can control the output to suit the requirements, secure an article sanitarily pure and avoid the expense of large storage houses, keeping only sufficient on storage to be prepared for emergency calls. We deem this question of the manufacture of ice by the road of sufficient importance to warrant the submission herewith of a plan, specifications and estimate for a 25-ton and 50-ton plant under the conditions to be met in New York city (see Appendix 1). These figures of cost include the plant complete (except the land on which it stands) including storage rooms of each 250 and 500 tons capacity respectively and refrigerating apparatus for keeping the ice in these rooms. This estimate is for a plant of the absorption type, but no discrimination is intended as against the compression system; each has its field of greater usefulness and higher efficiency. The main point to which we wish to call attention is the cost per ton of the ice as shown; this cost includes all items except water. Of course such an installation would be even more profitable to operate where as a side issue refrigerating effort could be supplied to cold storage rooms such as certain roads now operate. One large road running out of New York has now in operation a 50-ton ice-making machine (compression type) which with slack coal at 66c. per ton and common labor at 12c. per hour will, when running at full capacity, turn out the ice at a cost for operation of between 50c. and 55c. per ton.

Although the showing made by refrigerating plants is attractive, we shall assume in our further discussion the use of natural ice by the carrier, as that is the more commonly used.

There are relatively very few points where a small ice-house is needed. For general station purposes a plentiful supply of good water is necessary; this is secured in small outlying towns and villages by either a pump or well at the station or from the local water system; here ice for station water-coolers is not needed, and for sanitary purposes in the toilet rooms some such agent as chloride of lime answers better than ice. Where the size and importance of the town demands the use of ice it may be found cheaper to procure this small supply from local dealers as needed; but should several such places be grouped together on the line it may be found desirable to locate at one of these points a small house; this will certainly be the case if local passenger trains are started from that point, as ice in coach water-coolers is, during the summer season especially, practically necessary, and in coach urinals is highly desirable. It almost goes without saying that an ice-house should be located at or adjacent to each division terminal. Such a house should be built on the same design as the larger houses, with dimensions so altered as to meet the requirements of that particular locality.

Ice-houses for storing ice to be used for special purposes, such as icing refrigerator cars, are built according to the standard design, but are further equipped with special appliances for handling ice, breaking and carrying it, and mixing with salt. Where the ice is to be used for

but the single purpose, machinery for its handling may be introduced which will prove, if properly designed and adapted to the needs, highly economical.

In all ice-house construction the most important consideration is the

INSULATION.—The ideal ice-house is simply a storage chamber absolutely protected on all sides against the absorption of external heat and supplied with well-designed drains for the prompt removal of all water resulting from the little melting that in spite of all practicable precautions will occur. Heat travels or is conveyed by radiation, conduction and convection. For the purposes of this discussion the outside of the building and the ground (however themselves heated) may be assumed to be the source of the heat against which it is desired to insulate the storage chamber. Experiment has shown that cells or small chambers of dry, dead air form the best insulator. In the proportioning of these air-spaces two facts must be borne in mind, (1) the intensity of radiant heat varies inversely as the square of the distance from the source and (2) soon as a current, however slight, of air is formed in any air-space, heat is carried by convection around in that chamber. Of course two air-spaces are more effective than one, and three more than two, but there is an economic maximum dependent on the circumstances of each case.

MATERIAL OF CONSTRUCTION.—Wood is best adapted for use in buildings of this character, being of itself a non-conductor of heat, and not retaining the heat as does either natural or artificial stone, it permits the cheapest and at the same time the most efficient construction. In some municipalities certain regulations have been established governing the construction of all buildings within the "fire limits" and such laws usually are directed first to the materials of construction; at such a point it will be well to consider the advisability of locating the proposed ice-house beyond these fire limits to conserve the use of wood in the construction.

PLAN.—All ice-houses should be built in sections, the size of section being governed by the quantity of ice used; in some cases it is advisable to construct across each section lateral partitions which will still further reduce the amount of ice exposed to contact with the outer air while part of the stock is being removed. The building should stand with the gable end of the sections to the track, the doors then coming in the ends of the sections. At the centre of each section and at about the level of the first door should be placed a platform, say 6x10 feet.

PROPORTIONS.—Assuming that a cubic foot of ice weighs 57.2 lbs., a ton of solid ice would occupy about 35 cubic feet. Some years since, 40 cubic feet were considered ample in which to store a ton of ice cut in such sized cakes as are usually stored, but that allowance has been increased to 45 and even 50 cubic feet. In storing ice, good practice requires each cake to be stood on edge, leaving at least an inch air-space on four sides of the cakes. Ice less than 10 inches in thickness, or not perfectly solid, it does not usually pay to store; the thicker it is the better, but the cakes in any one layer should be all of the same dimensions to secure the best results. The layers should be crossed. The practice of laying each cake on the flat and as close as possible to those adjacent and filling all interstices with finely-broken ice is to be condemned—it costs more for labor, the wastage is greater than in the method before described, and when the ice is to be taken out, it is difficult to get good, merchantable cakes.

No covering should be placed on the ice after it is in place in the house; an inorganic substance, such as asbestos, would make the ice

dirty and be too expensive to use; any organic matter, such as that generally employed—hay or sawdust—not only dirties the ice, but, being dampened by the melting, soon begins to rot, decompose, and become foul. For this reason, the use of any organic matter between walls is to be deprecated. The use of short-fibre asbestos in the outer air-space (see section) has been suggested, but not to our knowledge tried; however, at a weight of 12 lbs., per cubic foot and at a cost of $16 per ton in car-load lots. f. o. b. New York, the expense is practically prohibitory. This asbestos, if used loosely, as it should be if at all, settles after being wet, and though it still retains its spongy character, is reduced in volume, leaving the upper portion of its confining chamber empty.

Site.—While little scope is usually given in the selection of a site, there are certain precautions to be taken in order to secure a good bed. If the site chosen be on a little rise above the adjacent ground level, surface drainage will give no trouble; otherwise, provision for it, as well as for the water from the melting ice, must be made.

Preparation for the Bed.—Assuming the ground to be good, the excavation below frost-line is made for the house foundations, and about two feet in depth inside the foundation for the reception of the bed. If the digging shows a clay soil, drains should be provided to carry off the water from the ice, and these drains should be air-trapped.

Cinders or gravel should then be placed in the excavation, as a bed whose top should be raised slightly above the surrounding ground level and inclined with an easy and gradual slope to the centre. On this bed, before ice is stored, rough hemlock plank should be laid with, say two-inch spacing to keep the ice off the bed itself, yet permit the water to pass through readily. A good concrete floor, well drained from the centre, would make a better job and be more satisfactory, but its cost precludes its general use in construction of this class.

Foundations.—The foundations, also, whether of wood, brick, or stone, should contain an air-space as a further insulation; heat may reach the storage chamber as well under as through the walls; in some cases this, we know, is the case.

Construction.—It is claimed by some that the side walls should be constructed with a batter, but your committee do not approve this idea; the idea is evidently to relieve the side walls of any pressure that may be brought upon them by the spreading of the mass of ice as it melts, but if the slightest care has been exercised in the storing of the stock, that condition will not be found to exist, especially as the ice naturally melts most on the outside of the mass; at any rate, in order to be effective, assuming such a condition to exist, the batter would have to be increased over any we have yet heard proposed.

If considered necessary, to resist wind pressure, etc., the sills may be tied to the foundation. They should, on a brick or stone foundation, be laid in a lime mortar in any event. The sketches shown herewith illustrate the recommended construction. The sheathing, with the exception of the outside, may be rough. While there will be three extra courses of this rough sheathing over what is usually found, the lumber is cheap and the results obtainable will fully warrant the slight increase in cost.

The paper used should be saturated (not painted or coated) and laid with laps to the centre of the sheet, virtually giving, then, two thicknesses of the paper in each lining. The sheets should be well cemented together, and the paper tacked securely to the sheathing. A

paper similar in character to the "Giant" of the Standard Paint Co. is recommended, which running, say 80 to 85 lbs. per roll of 36 inches width and containing 1,000 square feet, will cost about $6.25 per roll in place, including cement and tacks. With this paper, should be used a cement similar to that used for roofing purposes, which must be flexible (not brittle), strong, inodorous, and lasting. The job, when properly done, will make each space air- and water-tight. The construction here recommended is the best practice of commercial cold-storage houses, only so modified as to be cheap to construct, while yet retaining practically all the advantages of a more expensive construction.

At each gable end ample ventilators should be placed, permitting a free and full current of air over the ceiling of the storage chamber. The roof should be shingled and the valleys between sections well lined. There is nothing, apparently, gained by having the doors, through which to handle the ice, vertically continuous. A stiffer frame, freedom from excessive sag of the lower doors, and a closer, tighter fit of each door are secured by introducing a stiff sill framed under each door.

As may be inferred from the foregoing, we do not approve the use of tie-rods to "stay" the sides of the sections, because of their unreliability; they must of necessity sag under the weight of the superimposed ice and then they either spring the side walls in, or, because of the low temperature and tension to which they are subjected, break; even in the latter event they spring the side walls more or less before they let go.

A rigging amply stayed should be located over each line of doors to take the hook of the pulley for the hoisting rope in handling the ice in and out of the house.

A couple of coats of a good, light-colored, zinc paint should be applied to the outside of the house.

In a general report, to cover such a variety of conditions as are to be met in the service of the roads here represented, it is manifestly impossible to give any proportions that may be used in all cases. We, therefore, are unable to give an estimate of cost for such a house as is herein discussed for all localities. However, that will be no difficult matter for any one familiar with the conditions to be met, to compile. Should three or even four air-spaces be found necessary, sufficient data is here given to enable the one in charge to make his estimate on the design recommended.

We attach hereto (Appendix 2) plans of two ice-storage houses, a photograph of a plant for icing refrigerator cars, and a plan of a refrigerator or cold-storage house.

Respectfully submitted,

W. B. Yereance,
C. M. Large.

APPENDIX NO. 1.

SPECIFICATION FOR TWENTY-FIVE TON ICE MAKING PLANT, ABSORBTION TYPE.

ICE-MACHINE.

The ice-machine is to be complete in every detail, and will have a capacity of making in every twenty-four (24) hours, twenty-five (25) tons, (50,000 lbs.) of perfectly pure ice from distilled water at a temperature of 60 degrees Fahr., or under. It will consist of the following parts, viz.:

One "Generator or Still," with its "Analyzer" and "Exchanger"; two "Ammonia Condensers," with "Rectifier"; one "Absorber"; one "Triplex Gould Power Aqua Ammonia Pump"; all necessary pressure gauges for steam and ammonia; all liquid level gauges of the Hiller safety pattern; all of the valves and connections between the several parts of the machine; those for ammonia being extra heavy throughout, and all ammonia screwed joints being fitted with lock-nuts or glands and gaskets to guard against leakage; or "Tight Joint" fittings if preferred; all ammonia coils, if not of the return band pattern, to be welded and continuous throughout their lengths, and made of reworked strictly wrought-iron pipe; all of the machinery to be first-class in point of workmanship and material, and thoroughly adapted for the work in question.

GENERATOR.—There will be one Generator with cast-iron shell; it will have a flanged tee at one end, to receive the Analyzer, and four lugs at the other end for carrying the Exchanger. It will have two steam coils of the return bend pattern, made of extra heavy lap-welded two-inch pipe with heavy steel return bends, with screwed joints soldered.

ANALYZER.—The Generator will be provided with an Analyzer having a cast-iron shell. This will be supplied with twenty (20) Analyzer trays.

EXCHANGER.—The shell of the Exchanger will be of cast-iron, and it will contain four spiral coils, continuously welded throughout their entire length, and made of 1¼-inch reworked pipe.

RECTIFIER.—There will be one rectifier coil of the atmospheric return bend type. It will be made of 3-inch lap-welded extra heavy wrought-iron pipe, made up with cast-steel counterbored return bends, protected with either glands or lock-nuts. This coil will be supported on channel iron standards, securely bolted together and arranged to carry the galvanized iron distributing trough. It will have four drip pockets to trap out all moisture from the gas and to insure anhydrous ammonia gas. The floor is to be prepared by the owners to drain away the water from the coil.

CONDENSER.—The Condenser will be in two units, each independently connected; the shells to be of cast-iron; each will contain four spiral coils continuously welded throughout their entire length, two of 1¼-inch and two of 1½-inch reworked coiling pipe. The condensers will be supported on a channel frame or bed plate, giving convenient access to the connections underneath. Each condenser will be arranged so that the coils can be independently clean; the tails of the condenser coils will be connected, top and bottom into 2½-inch headers or manifolds. It is understood that salt water will be used for condensing purposes.

Absorber.—The Absorber will have a cast iron shell, and will be provided with six spiral coils continuously welded throughout their length, and made of reworked coiling pipe. These coils will be as follows, in number and size of pipe: two 2-inch; two 1½-inch; two 1¼-inch; their ends or tails will be connected at inlet and outlet into cast-iron junction boxes with 3-inch water connections. The Absorber will be supported on cast-iron columns, resting on a cast-iron bed plate.

Aqua Ammonia Pump.—There will be one Aqua Ammonia Pump of the direct-acting pattern of any standard make which the consulting engineers may select, with steam cylinder 10 inches in diameter, pump cylinder 4⅛ inches in diameter, and a stroke of 10 inches. This pump at 40 displacements per minute will operate the machine to its full capacity.

If power pumps are used we will provide a 3⅛-inch by 8-inch Goulds Triplex power ammonia pump.

Pressure Gauges.—There will be three sets of 8-inch steel tube pressure gauges marked "Generator," "Cooler," and "Absorber," respectively; also one 8-inch steam gauge; all of these are to be iron cased, with nickeled rims; they are to be mounted in a cast-iron ornamental frame with shelf on brackets.

Liquid Level Gauges.—There will be five sets of our automatic safety gauges for indicating the liquid levels on Generator, Condensers, Cooler, and Absorber.

Ammonia Pipe and Fittings.—All connectings for ammonia are to be extra heavy lap-welded pipe; wrought-iron pipe only will be used. All fittings will be either malleable iron or steel castings, with joints protected by either lock-nuts or glands, with rubber rings. All unions will be flange unions with male and female joints with lead gaskets.

Testing.—After the machinery has been erected, it will be tested to 350 pounds hydraulic pressure before receiving the ammonia charge.

ICE TANK.

There will be one ice-making tank built of 3-16 in. plate iron, weighing seven pounds per square foot, properly braced and reinforced with angle iron rim. This tank will be 24 ft. wide, 38 ft. long, and 4 ft. deep. It will be erected on the premises, and calked and tested tight before being insulated.

Expansion Coils.—The tank will be provided with the requisite number of expansion coils, made of 1¼ in., extra heavy reworked wrought-iron pipe, and supplied with the necessary wrought-iron headers, straps, valves, and connections.

Ice Cans.—The ice cans, or moulds, will be 340 in number, made of No. 16 galvanized iron. They will measure 11 x 22 inches at the top, and be 44 inches deep, to form ice cakes of 300 pounds each. Around the top they will be reinforced by a 1½ x ¼ in. galvanized iron band. All joints on these cans will be riveted, the bottoms being set in one inch, and joints thoroughly soaked with solder.

Boiler.—There will be one 100 horse-power tubular boiler, 66 in. in diameter, and 16 ft. long, provided with either three 3½ in. or 4 in. tubes, as you may desire. It will be built of ⅜ in. flanged steel plate, with ½ in. heads. This boiler will be properly stayed, braced, tested, and inspected by your boiler inspector before bricking in.

Feed Water Heater.—The boiler will be furnished with a Cochrane Excelsior, or other approved feed water heater.

Boiler Feed Pump.—There will be one triplex power boiler feed pump, having plungers 3 in. in diameter, and with 4 in. stroke.

Engine.—There will be furnished one throttling governor engine of sufficient horse-power to drive the agitators in the ice tanks, one 50 light dynamo, and the necessary power pumps for operating the plant. If, however, steam pumps are selected, we will furnish a smaller engine in proportion to the work to be done.

Agitators.—There will be two propellers or agitators in the ice tank, so arranged in the proper bulkheads as to cause a continual circulation among the cans, and around the coils of the ice tank, thereby accelerating the freezing of the ice.

Shafting, Pulleys and Belts.—In case of power pumps, the necessary shafting, pulleys, and belts, hangers, etc., will be furnished to drive the pumps, agitators, and the electric light dynamo. All pulleys will be wood split pulleys; all hangers will have large, free bearings, and be adjustable; all shafting to be cold rolled. All belts double.

Ice Can Covers.—There will be 340 can covers made of either oak or ash, of two thicknesses, with paper between. The can covers will be supported on a frame work or crate made of galvanized iron and ash, and so arranged as to give a separate compartment for each can.

Crane and Hoist.—There will be one traveling crane, together with the necessary rails for the same. This crane will be provided with a geared hoist for lifting the cans from the ice tank.

Can Filler and Hose.—There will be one can filler of the automatic type, together with sufficient hose to reach from the sponge filter to any can in the tank.

Can Dump.—There will be one tilting frame or can dump, with automatic water sprinkling arrangement for liberating the ice from the cans. It will be provided with drip tanks and connections for taking away all surplus water.

Filter.—There will be one sand or charcoal filter, and one sponge filter to catch any sediment before the water enters the cans. These filters will be made of either cast-iron or heavy galvanized iron, and arranged with the proper perforated iron plates for holding the filtering material in place.

Distilled Water Tank.—The distilled water receiving tank will be 4 ft. in diameter, and 12 ft. high. The upper part of this tank is used as a deaerator; the middle section is provided with a water coil for cooling the water; and the lower, or bottom section, is provided with the return gas coil, which cools the water to a temperature of about 50 degrees before the same goes to the cans. This arrangement makes the distilling process a very simple one, and does not require the complex machinery used by a compression machine used for eliminating oil.

Connections.—It is proposed to furnish all the necessary steam, water, waste and exhaust connections, it being understood that you will bring the water and sewer connections within the walls of the building.

Electric Plant.—It is proposed to furnish one 50 light dynamo, together with wiring for that many incandescent lamps. This dynamo

to be of 110 voltage, and to be of the General Electric, Crocker-Wheeler, or any other approved make. There will also be one volt meter, one resistance box, and the necessary knife switch.

ICE STORAGE PIPING. — There will be sufficient direct expansion piping in the ice storage room to carry the same at a temperature not above 30 degrees Fahr. All coils will be continuously welded, and of the return bend pattern. They will be so arranged in the room as to give a proper distribution of cold, and prevent ice melting at any particular point in the room. It is very important to arrange this piping properly, otherwise any melting of the ice at one portion of the room endangers the remainder, owing to the liability of the cakes freezing together.

WATER PUMP.—There will be one Gould triplex water pump having plungers 6½ inches in diameter, and 8-inch stroke. If steam pumps are used there will be one 8 x 7 x 10-in. steam pump substituted.

STEAM CONSUMPTION.—If it is desired to make pure distilled water ice it will be necessary to make sufficient steam for 25 tons of ice. With an actual boiler evaporation of 8 to 1, the steam consumption will be 3 tons of coal per twenty-four (24) hours. If power pumps are used and the engine exhaust is used in the generator, after it has done its work in the engine, the coal consumption will be 2¼ tons per day, based on an actual boiler evaporation of 8 to 1. In this case it is proposed to eliminate the oil between the engine exhaust and the generator by means of a Cochrane steam separator. The condensed steam from the generator will then pass off to the deaerating tank. A small amount of the steam from the engine exhaust will go to the Cochrane feed water heater, and there heat sufficient water for the boilers, and also for making up the deficiency of distilled water for the ice cans. This water will be sufficiently heated in the open feed water heater to liberate all of the air from it, thus insuring a comparatively clear ice. In case of direct acting steam pumps, the steam from these pumps would be treated by means of a separate reboiler before passing into the distilled water tank to mingle with the generator exhaust. We think that the saving, with fuel at $1.38 a ton, would amount to about $1.10 per day, or about 4½ cents per ton. We would require 100 gallons of water per minute at 60° to do the above work.

GUARANTEE.—All material and workmanship used in this work will be of the very best quality and finish on all parts equal to the standard of good engine work finish. We will guarantee that the coal consumption, with a boiler evaporation of 8 to 1 will not exceed 6,200 lbs. weight per twenty-four (24) hours when distilled water ice is being made, and 4,500 lbs. weight in case engine exhaust is used in generator. With condensing water at 60° Fahr., the water consumption shall not be more than 100 gallons per minute.

PROPOSITION.

We propose to construct, deliver, and erect in a building suitably prepared by you for its reception and erection, one of our Pontifex-Hendrick ice-making plants for the manufacture of twenty-five (25) tons (50,000 lbs.) of ice per day.

Our price for this machinery erected anywhere within the limits of Greater New York city, all as per specifications attached, is as follows, (the figures in the right-hand column are for a 50-ton ice plant similarly constructed):

	25-ton plant.	50-ton plant.
With steam pumps	$19,500.00	$29,500.00
With Gould's power pumps	20,000.00	30,250.00

SYNOPSIS OF COST.

We estimate the cost of building suitable for these plants to be as follows:

Building	$3,000.00	$4,500.00
Tank insulation	400.00	800.00
Room insulation	800.00	1,500.00
Boiler setting	450.00	900.00
Margin	950.00	1,300.00
Total cost,	$5,500.00	$9,000.00

This brings the total cost with power pumps, excluding property, as follows:

25-ton plant	$25,500.00
50-ton plant	39,250.00

We estimate the cost of manufacture while running the plant nine months full time, and one month one-half time, and shutting down for the other two months, to be as follows:

Running Expenses.

	25-ton.	50-ton.
Fuel at $1.38 per ton	$1,179.90	$2,359.80
One engineer at $75	712.50	712.50
One assistant at $60	570.00	570.00
Tankmen	712.50	1,425.00
Two firemen	855.00	855.00
Ammonia	300.00	500.00
Salt	30.00	40.00
Oil	55.00	70.00
Electric plant	15.00	15.00
Packing, waste, etc.,	50.00	100.00
Reports, etc.,	25.00	25.00
Total	$4,504.90	$6,672.30
Tons ice yearly	7,250.00	14,500.00
Cost per ton	.62	.46

Fixed Expense.

Cost of plants taken at $27,000 and $40,000:

	25-ton.	50-ton.
Interest 6 per cent.	$1,620.00	$2,400.00
Depreciation, 4 per cent.	1,080.00	1,600.00
Taxes, ½ per cent.	135.00	200.00
Insurance	180.00	300.00
Total	$3,015.00	$4,500.00
Cost per ton	.41	.31
Operating as above	.62	.46
Total cost per ton	1.03	.77

Hendrick Mfg. Co., Ltd.

APPENDIX 2.

Ice-House Plant Designed for Icing Refrigerator Cars.

Capacity about 10,000 tons. Building proper rests on stone piers and the ice on timbers imbedded in cinders resting on the ground.

Insulation.—Ten-in. walls (between studding) stuffed with sawdust with matched sheathing inside and out. Water-proof paper on inside of this, and a dead-air space formed by furring strips and inside sheathing fastened on these strips.

The building has a platform between it and the track, and the ice is stored by hoisting-in gigs from the outside. To take the ice out, another inside gig is arranged, running from the centre of each room to a high attic, and thence the ice runs by gravity to the centre of the building, where it drops into a crusher, and from there falls to the storage room for crushed ice below, or into carts, as desired. The carts are then run on to the elevated platform, which is on level of the floor of the crushing room, and dumped into the car tanks by gravity.

When it is desired to take out and use cake ice, the cakes slide into the drop, by turning a switch, instead of into the crusher; and from the temporary storage room are run on to the elevated platform by hand.

The office, superintendent's residence, men's room, and sleeping rooms for the night force, are in a separate building.

The cost of this building complete, with machinery, is about $25,-000, of which $2,000 represents the cost for machinery. All work is done by electric power, supplied from adjacent, outside source.

Specification for a Refrigerator and Freezing Rooms at Fabyan's, N. H.

The contractor for the building will put up the studding for all partitions and put down the lining floors.

The contractor for the refrigerator is to put in the finish floors, ceilings and walls, with all necessary insulations to make a complete and sure working job.

The freezers are to maintain a temperature of about 18° or 20° above zero, and the refrigerator about 40°.

The ice closets are to be lined with galvanized iron, and the floors of these and the passage-way are to be made water-tight by the use of galvanized iron laid down and extended well up on the walls for protection. These floors to be drained with proper pitch to carry off all water to a 4-in. cast-iron soil pipe, which the contractor must lay to discharge into the river or suitable pit.

Water will be supplied to the building from the hotel through a ¾-in. galvanized iron pipe.

The contractor is to put in this pipe and make connections with a sink in the cutting room and an outlet in the passage-way. The sink will be furnished by the railroad, but the contractor must furnish and place the cock and outlet to discharge into the soil pipe as above. The outlet in passage must be furnished with a brass hose bibb and short length of hose for washing the ice.

The contractor must arrange in the passage-way a sheave and fall for conveniently transferring the ice from the ice-house to the ice closets.

The inside finish of freezers and refrigerators will be spruce, finished in the natural wood.

The contractor is to furnish all necessary drawings and sections to illustrate his system, and also a specification of how he proposes to put it in.

The contractor must guarantee his work to operate satisfactorily, and must protect and save harmless the railroad from all claims for infringement of patent rights.

In the plan of the Wabash Standard Ice-house, it will be noticed that the walls of house are built on a batter of 6 inches on each side, the object of which is to avoid any pressure against side walls when the ice settles. It is constructed of two rows of studding tied together every 4 feet in height by 1-inch x 6-inch boards. These studdings are covered with rough boards nailed on horizontally on the inside of studding, and the space thus formed is filled with sawdust. The outside is covered with dressed siding put on without battens. This forms an air-space between out and inside walls. The cost of this house is as follows:

Size, 26 x 40 feet.
Pile foundation, shingle roof.

Material,	$228.92
Labor,	219.02
Total cost,	$447.94

SPECIFICATIONS FOR AN ICE-HOUSE FOR THE WEST SHORE R. R.

DIMENSIONS.—This house will be as shown on plan, which is to be considered part of this specification. The entire building will be 63 feet, 8 inches wide by 88 feet, 9 inches out to out of finished work measured on the ground line.

DRAWINGS.—Plans, sections, elevations, and details of construction are all shown on one sheet; any other drawings or sketches that may be furnished during construction will be of equal force with those embraced on the one sheet above described and equally binding upon the contractor.

MATERIALS.—All of the posts and platforms upon which they rest will be of chestnut or white cedar, of dimensions given.

All of the framing timbers, studding, etc., will be of Pennsylvania white hemlock, sawed true and square, and to hold true to dimensions given. All to be sound, free from sap, wayn, shake, and unsound knots, and subject to approval or rejection of inspector in charge of work.

SHEATHING.—Sheath the inside of each compartment of the building, on all sides, horizontally from under edge of sill to top of plate, also the under side of roof purlines from plate to ridge, and outside gables from plate to peak of roof, all with 1-in. x 10-in. white hemlock sheathing boards, laid edge to edge with tight joints. All sheathing to be laid in strings of five boards. At corners the boards will be arranged on posts, as shown in detail sketch, so as to thoroughly tie the corners; all sheathing boards to be not less than 12 feet long and to be secured twice to each bearing with 10-penny nails—72 to the pound. No patching or piecing that can possibly be avoided will be allowed, and in all cases butt joints must be made to come over centre of bracing.

ROOF COVER.—Cover the entire roof with second quality of sound Michigan white pine shingles, clear butts, clear from sap, wayn, or shakes, shingles to be laid 5 inches to the weather on 1¼ inches x 5 inches white hemlock shingle strips, laid the proper distance apart and securely nailed to the rafters, twice over each rafter.

OUTSIDE SHEATHING.—To be of good quality of white pine Novelty siding, of pattern shown in sketch. All to be sound, free from large and loose knots and shakes, and to be well seasoned. Form siding in panels as shown on drawings, and use for corner boards, stiles, base and fascia, 1¼ inches white pine, free from defects (same as for siding), of widths required by plans, and bevel abutting ends, and securely nail to under work, as required by inspector, all of the outside sheathing and banding, etc. N. B.—Make windows and slats in gables all of white pine.

SAWDUST FILLING.—Fill up in the most thorough manner, all spaces between joists, posts, etc., with sawdust well packed in at time of putting on siding, sawdust filling to include all spaces of outside walls. Compartments and outside gables will be sawdust filled. The outside end gables will be vertically ceiled with 1-inch white pine, tongued and grooved ceiling boards, pointed at lower end, as shown on drawing, with fascia run up the rake.

DOORS.—Make the three section doors for each opening in accordance with detail sketch shown on plan, and fill in between inner and outer sheathing with packed sawdust. Hang doors on wrought-iron strap hinges, and provide hasp and padlock for each section of each door. The outside sheathing of narrow white pine T & G'd ceiling, inside of hemlock, also framework of doors.

TIES.—The building will be tied together under the line of each truss, at a point midway between plate and sill, with a ⅞-inch diameter tie-rod, secured to eye bolts run through the 8x10 inch posts with nuts and washers outside of posts. There will also be a tie sill under line of each truss, dovetailed at ends into the longitudinal sills and bolted at ends.

GRADING AND FILLING.—The ground inside of building, each compartment, will be neatly graded off from below top of tie sill at longitudinal centre, and sloped off toward sides of each compartment to a point 2 inches below longitudinal sills, and the grading so made covered with about 4 inches of coarse gravel, and over all lay a loose covering of 2-inch hemlock plank, ½ inch spaces between plank.

PAINTING.—Paint all weather-exposed faces of building with two good coats of Williamsport National Paint Company's mixed paint on priming of French ochre ground in linseed oil; tints to be numbers 28 and 29. Shellac all knots and putty stop all nail holes.

WORKMANSHIP AND MATERIALS.—To be first-class in every respect and in full accordance with plans and specifications, and all work shown or implied must be thoroughly performed, and the building must be left broom clean and in every particular complete and ready for use and to the entire satisfaction of the chief engineer.

APPENDIX 3.

SPECIFICATION FOR 25-TON AND 50-TON ICE-MAKING PLANTS ON COMPRESSION SYSTEM.

The drawings, with their plans and sectional elevations, practically explain themselves. In the 50-ton arrangement there are three ice-houses, to accommodate 500 tons each. Future ice-houses can be added to meet requirements. The prices given assume that the railroad company will furnish the buildings and foundations: contractor for the ice-plant to deliver the machinery and erect the same in said buildings.

The general arrangement of both plants is compact, convenient, and buildings arranged as simply as possible.

For operating the plants, we would submit the following figures:

For the 25-ton plant:

1 day engineer	
1 day fireman	
1 night engineer	
1 night fireman	
2 tank men	
Coal, 7,000 lbs.	
1 man in ice-house	
Oil, waste, and sundries per day	$2.50

For the 50-ton plant:

1 day engineer	
1 day fireman	
1 night engineer	
1 night fireman	
3 tank men	
Coal, 14,000 lbs.	
1 man in ice-house	
Oil, waste, and sundries	$4.00

It would be possible on the 25-ton plant to run the factory with one engineer who did his own firing. This is done in many instances.

The 50-ton plant shows the arrangement of ice storage house used by some of the roads, a portion of the ice-house being used for machinery, a room being built on the end for the ice-machine, with the distilling and condenser house one story above, shed room for the boiler. If the distilling apparatus was not required, the ammonia condenser could go on the roof above the engine-room, and the distilling house built above the engine-room would not be required, simply a slat-work protection for condenser.

SPECIFICATION FOR 25-TON ICE-MAKING PLANT COMPRESSION SYSTEM.

GAS COMPRESSORS.—Ice-machine to have two single-acting, vertical gas compressors, fitted with water jackets. Gas pumps to be 12-inch bore, 24-inch stroke.

STEAM ENGINE.—Corliss valve gear, direct, connected, horizontal style, with steam cylinder 19-inch bore, 24-inch stroke, plain fly-wheel 8-feet diameter, to weigh 9,000 pounds.

MACHINE and engine throughout to be fitted with suitable lubricating devices, arranged for continuous running; stop-valves, wrenches, foundation bolts, and anchor plates.

GAS CONDENSER.—To be of surface style, with 1,920 running feet of straight coils, 20 feet long, 24 high, made of 2-inch extra strong pipe, with stands, valves, sprinklers, and headers.

TRAPS, RECEIVER AND PRESSURE GAUGES.—To be complete with suitable valves, fittings, and necessary pipes to connect compressors, condenser, evaporating coils, and receiver.

FREEZING TANK SYSTEM.—One freezing tank made of steel ¼-inch thick, 56 feet long, 24 feet wide, 4 feet high, fitted with evaporating coils, of 1¼-inch extra strong pipe; 400 galvanized freezing cans No. 18 gauge, size 11x22x44 inches, for making cake of ice weighing 300 pounds; suitable wood framework for supporting cans, with cover for each; hand hoist and traveling crane; automatic thawing dump or dip tank; propeller for agitating brine, with independent engine and belting for driving same; freezing tank system to be complete.

DISTILLING SYSTEM.—Having galvanized iron purifying, filtering, and deodorizing apparatus, for using exhaust steam from engine, consisting of steam condenser, reboiler, hot and cold distill water filter, storage tank, fitted with coil, cooling oils, coke steam purifier, sponge filter, and galvanized pipe connections; back pressure valve and oil separator, all to be complete, including automatic can filler and hose for filling ice cans.

STEAM BOILER SYSTEM.—Consisting of one horizontal tubular boiler, of 125 horse-power, with shell 72 inches diameter, 16 feet long, containing 92 tubes 3½ inches diameter, complete with full flush front and all fixtures, mountings, and fittings; smoke flue or stack, 35 inches diameter, 50 feet long; one duplex steam feed-pump, size 6x4x6, necessary steam and water-pipes to connect boiler, engine, feed-pumps, and distilling apparatus.

CHEMICALS FOR CHARGING MACHINERY.—One full charge of salt for making brine, and charge of pure anhydrous ammonia.

ERECTION OF MACHINERY.—One competent engineer to be furnished to superintend the erection of machinery, together with necessary erecting tools, this engineer to remain not to exceed thirty days after plant has been started, for the purpose of instructing the permanent engineer in the operation of the machinery.

DRAWINGS.—Necessary plans, together with instructions for operating machinery, and working plans and specifications for buildings to accommodate the ice plant, to be furnished by contractor.

PAINTING.—Machinery before leaving the works to be painted two priming coats of paint; all coils, pipes, and tanks to be painted with water-proof paint. After machinery has been erected contractors are to handsomely paint, stripe, and varnish the machinery and engine.

INSTRUMENTS.—Two salt gauges for testing brine; two thermometers for taking temperatures in freezing tank.

GUARANTEE.—Machinery, as above specified, will produce twenty-five tons of merchantable ice per day of twenty-four hours, when run continuously and operated according to instructions; workmanship and material to be best of their several kinds; parts proven to be defective within one year after starting to be replaced by contractor, natural wear and tear, accident, neglect or incompetency of purchaser or his employés excepted.

It is intended that when details are not mentioned in the above specifications, but necessary for completion of the ice-making machinery, the same are to be furnished by the contractor as if specified.

PURCHASER TO FURNISH THE FOLLOWING.—Buildings to receive machinery according to plans; engineer to assist during erection and testing of machinery, in order to receive instructions for operating the same from the erecting engineer; needed water for use on gas condenser; foundations for machinery, together with all masonry and carpenter work, and materials and insulation as required; to supply light, fuel, oils, water, and steam needed for test; and during erection provide all drains and sewer connections.

Contractor to pay transportation of machinery to destination, within four hundred miles of New York City: and to supply all necessary common labor and help, as required by the engineer for erecting machinery.

Prices for 25-ton ice plant, as per specification:

Complete plant erected	$20,400.00
Omiting distilling apparatus and connections ($1,200)	19,200.00
Omiting distilling apparatus ($1,200) and boiler ($1,400)	17,800.00
Substituting a horizontal Corliss, double-acting, tandem, ice-machine, in place of a vertical, single-acting, compressor, complete plant . .	19,400.00

See plan enclosed for 25-ton ice factory, which may be modified to suit location, and whether or not a distilling apparatus is required.

SPECIFICATION FOR 50-TON ICE-MAKING PLANT COMPRESSION SYSTEM.

GAS COMPRESSORS.—Ice-machine to have two single-acting, vertical gas compressors, fitted with water jackets. Gas pumps to be 15-inch bore, 32-inch stroke.

STEAM ENGINE.—Corliss valve gear, direct, connected, horizontal style, with steam cylinder, 24-inch bore, 32-inch stroke, plain fly-wheel 11 feet diameter, to weigh 16,000 pounds.

MACHINE and engine throughout to be fitted with suitable lubricating devices, arranged for continuous running; stop-valves, wrenches, foundation bolts, and anchor plates.

GAS CONDENSER.—To be of surface style, with 2,880 running feet of straight coils, 20 feet long, 24 high, made of 2-inch extra strong pipe, with stands, valves, sprinklers, and headers complete.

FREEZING TANK SYSTEM.—Use two tanks and details as previously specified for 25-ton plant.

DISTILLING SYSTEM.—Of 50 tons capacity, general specification same as 25-ton plant.

BOILER SYSTEM.—Two boilers, used same otherwise as specified for 25-ton plant, except feed-pump, 9x5¼x10.

GUARANTEE, ETC.; DELIVERY, ETC.—Same as for 25-ton plant.

Price for 50-ton ice plant, as per specification:

Complete plant, erected	$34,500.00
Omitting distilling apparatus and connections .	32,500.00
Omitting distill and boiler system	30,500.00
Substituting a horizontal Corliss, double-acting, tandem, ice-machine, in place of vertical, single-acting machine, complete plant	32,700.00

See plan from Newburgh Ice-Machine & Engine Co., Newburgh, N. Y., for 50-ton ice factory, subject to modification to suit location.

Fig. 2.—Design for Standard Ice House Section, recommended by the Committee on "Ice-Houses."

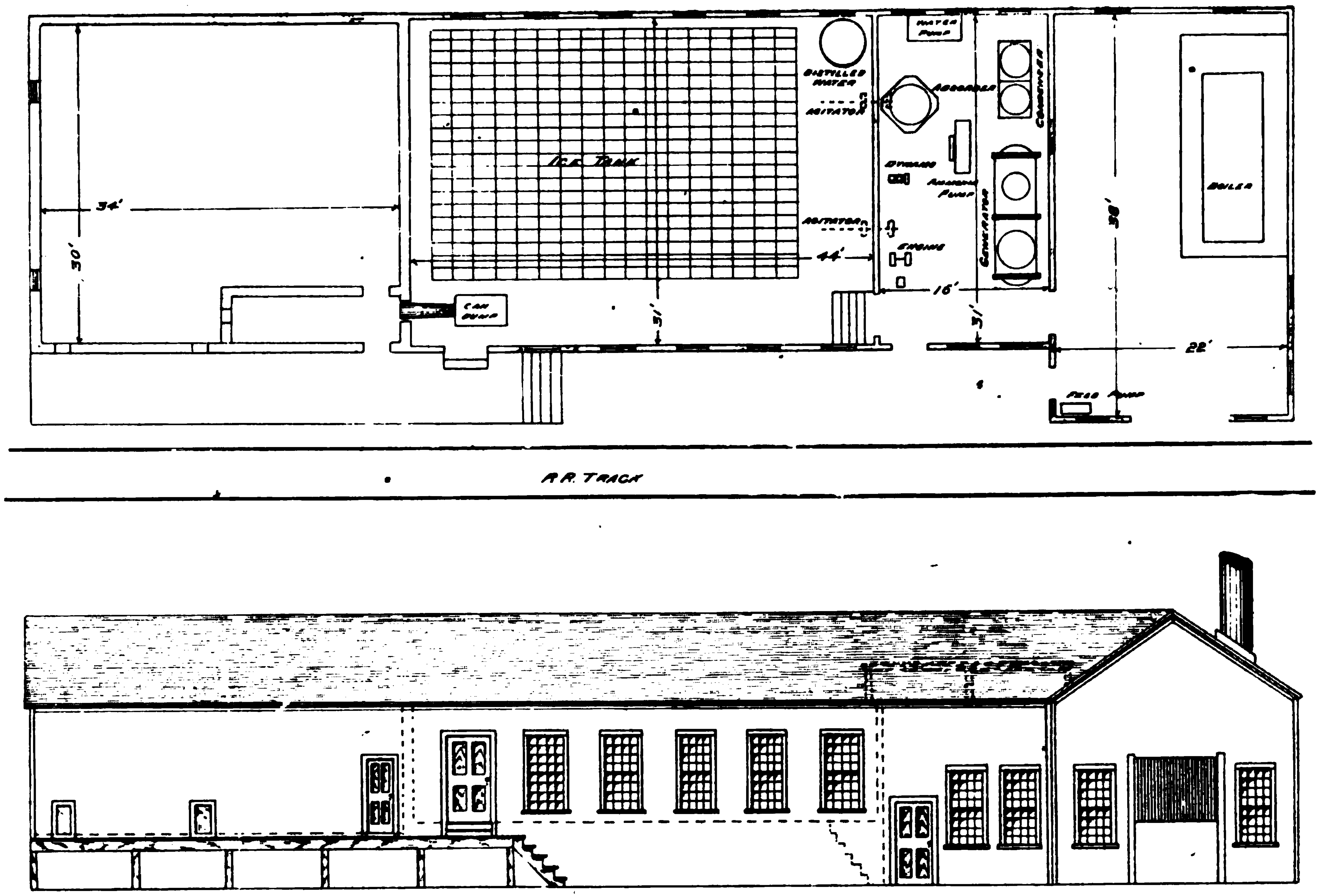
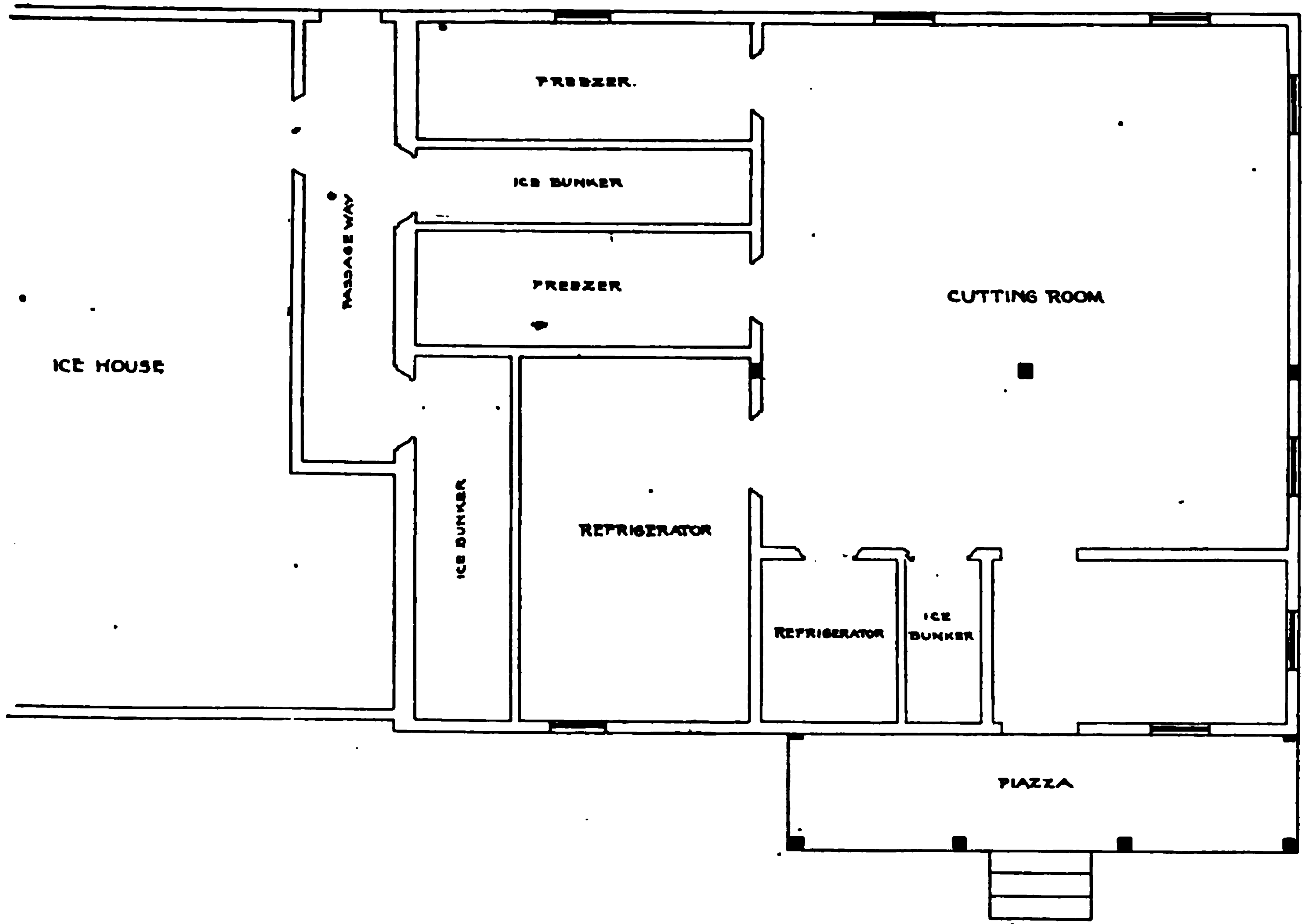


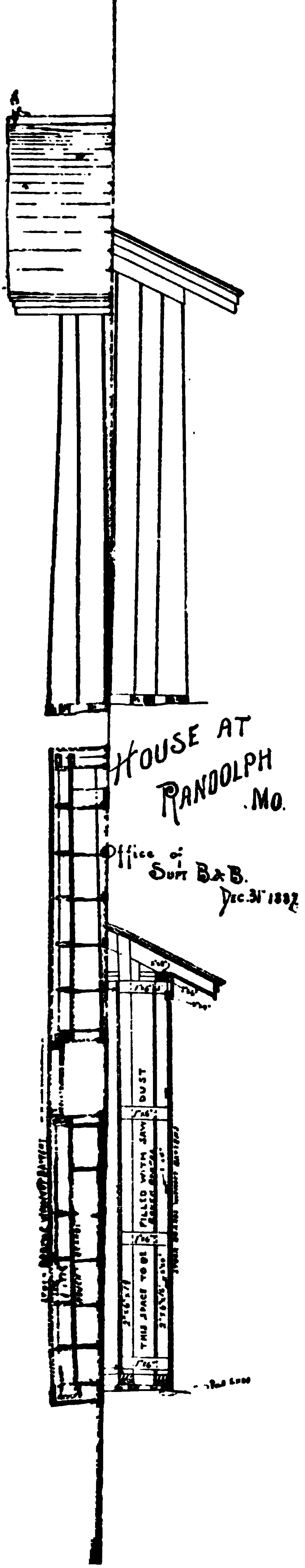
FIG. 3.—Plan for 25-ton Ice Making Plant, designed by The Hendrick Mfg. Co., Limited, of Carbondale, Pa. (Appendix 1, Committee Report on "Ice-Houses.")

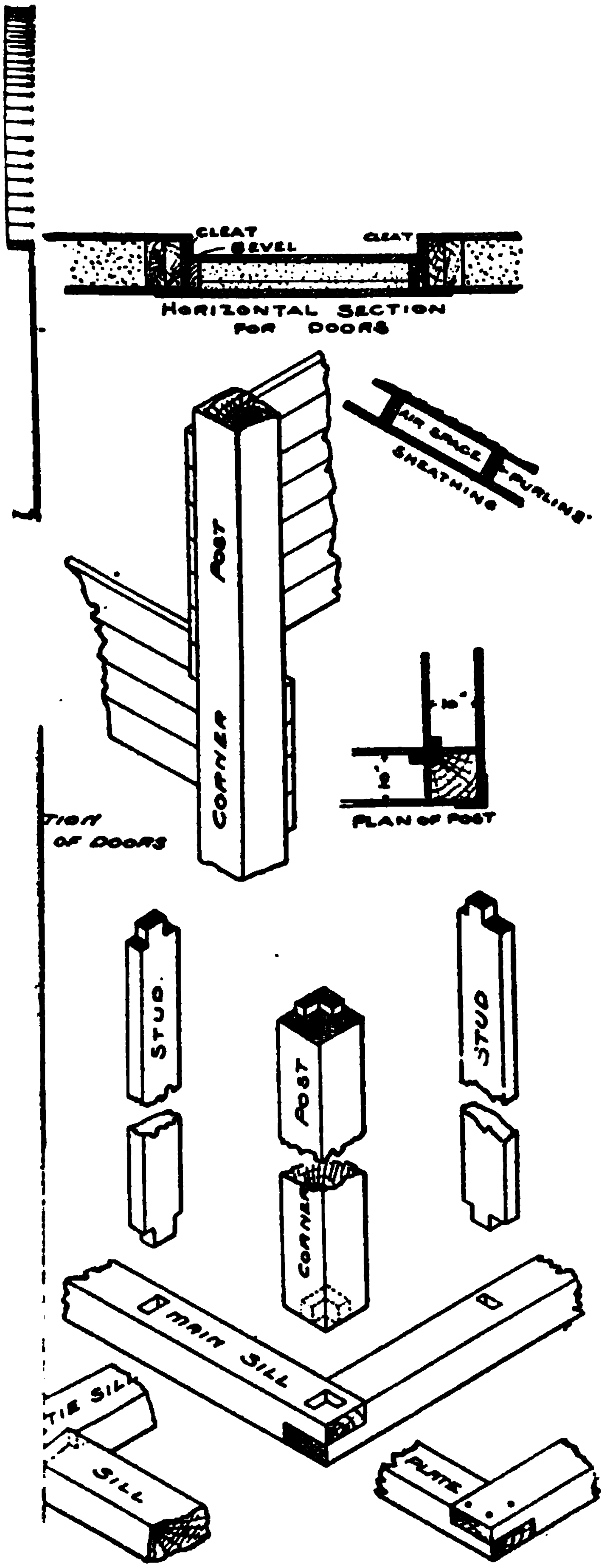
FIG. 4.—Ice-House Plant for Icing Refrigerator Cars at Altoona, Pa. (Appendix 2, Committee Report on "Ice Houses.")



FLOOR PLAN

FIG. 5.—Ice-House and Refrigerator Building at Fabyan House, N. H., Boston & Maine R. R. (Appendix 2, Committee Report on "Ice-Houses.")


HOUSE AT RANDOLPH .MO.
Office of Supt B&B.
Dec. 31st 1887
THIS SPACE TO BE FILLED WITH SAW DUST



CLEAT
BEVEL
CLEAT
HORIZONTAL SECTION
FOR DOORS
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SHEATHING
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TIE SILL
SILL
PLATE

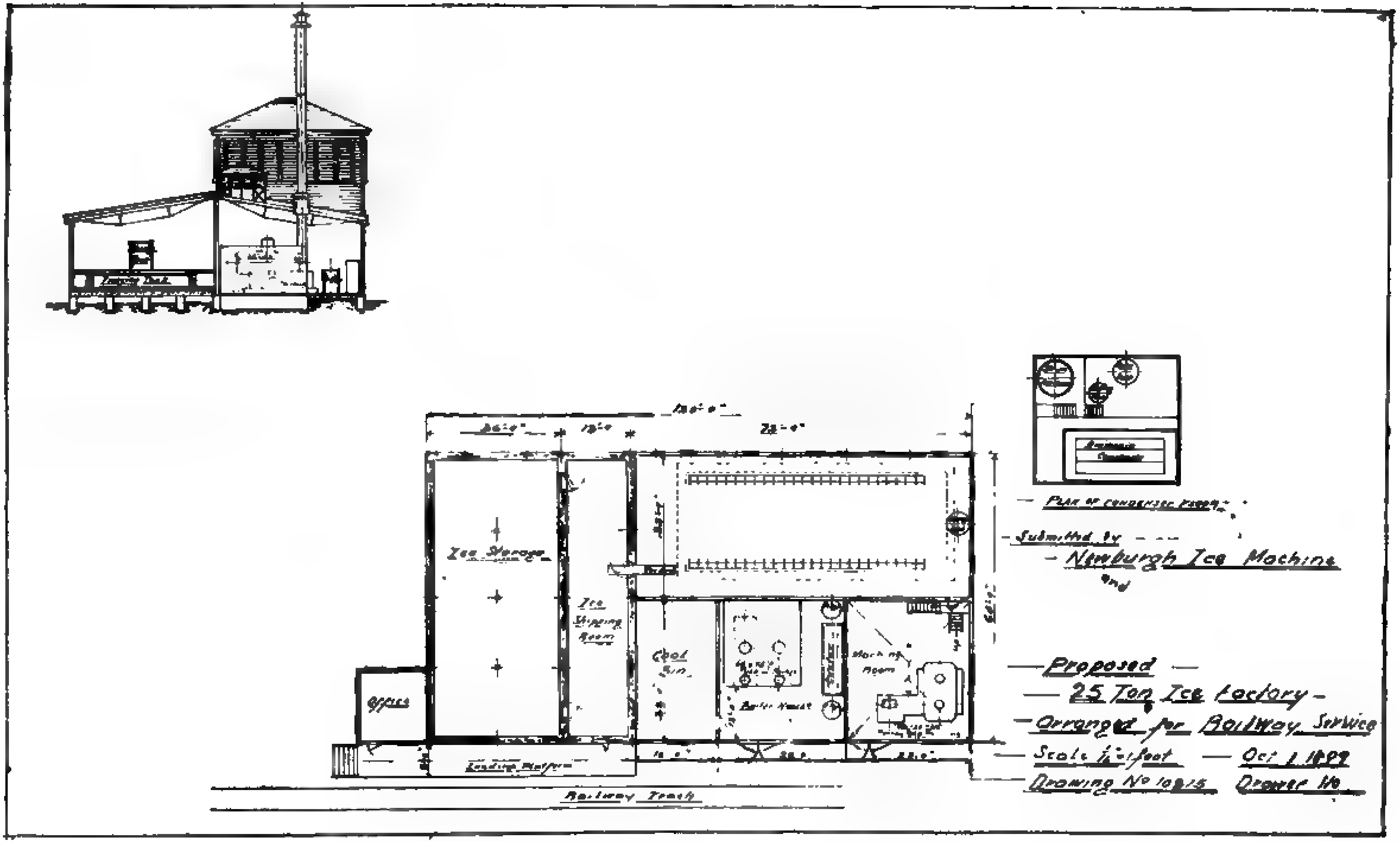
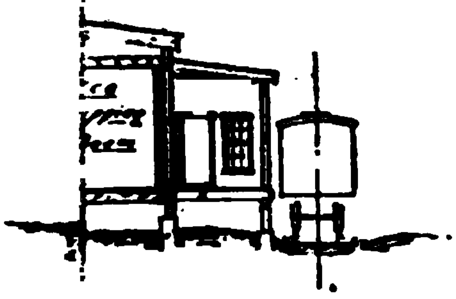


FIG. 9.—Plan for 25-ton Ice Factory arranged for Railway Service, designed by Newburgh Ice Machine and Engine Co., Newburgh, N. Y. (Appendix 8, Committee Report on "Ice-Houses.")



Ice Machine
Company
burgh, N.Y.

tory
ilway Service
Oct. 1, 1897
Drawer No.

es.")

DISCUSSION.

Mr. Bishop.—On my division of the C., R. I. & P. Ry., we build our ice-houses with a batter, using 2 x 8 for studding. The heights of ice-houses are from 18 to 20 feet, with 12-inch batter in the height. They are filled in, between the 2 x 8 studding, with sawdust, and sheeted on the inside and outside with shiplap, and tar-paper on the inside of the sheeting on the inside of the house, and on the outside of the sheeting on the outside of the house. On the outside of the building, we nail a 2 x 3 furring, to form an air-space, using tar-paper on the furring, and on the outside of that, drop-siding or lap-siding. This forms an air-space of 3 inches. We ceil up the rafters about half way, and ceil across the collar-joist, which forms an air-space. We place a ventilator on top of the roof, 6 feet wide, and 8 to 10 feet long. The number of ventilators required is decided by the length of the building.

President.—Do you use any struts or iron rods through your house?

Mr. Yereance.—Why do you use a batter if the ice shrinks?

Mr. Bishop.—Our batter ice-houses require no tie-rods, and we use fence-flooring for sheeting the roof, and shingle the roofs. We have a number of ice-houses on my division that were built by contract, about ten years ago. They are vertical, and are 24 feet high. They have 2 x 8 studding, sheeting on the inside and out with shiplap, and 2 x 3 flooring strip on the outside of the studding. When they pack the ice in the ice-houses, they fill in between the sheeting and the ice with 2 or 3 inches of sawdust, and when the ice settles, it bulges out the side of the house, and it is often necessary to put in rods, to keep it from bursting out.

Mr. Carmichael.—On the Union Pacific we pack the ice close up to the inside of the building. We do not use anything between the ice and the wall. Our houses are all about 16 feet high and batter 12 inches in the 16 feet, making the house 2 feet smaller at the top than at the bottom and in addition to this the floor falls 6 to 8 inches from the sides to the centre, where we have a drain trough that runs from the front to the rear of the

house. This drain has about 3 inches fall, and connects with a drain tile and trap. This style of building does away with the necessity of rods to prevent the ice from bursting the building. The ice being packed same shape as the building as it wastes away it settles towards the centre of the building and relieves the building of pressure.

Mr. Berg.—I think it would be desirable to bring out the opinions of the members on the well-known question of sawdust *versus* air-space. It will probably be found that the various opinions are quite different. The usual disadvantage claimed when using sawdust is that it absorbs moisture and with moisture naturally decay will start earlier. Therefore, a great many ice-house builders advocate air-spaces entirely. Other important questions are the insulation of the roof and side-walls; good ventilation over the top of the ice so as to keep the ice sweet, in ice-house parlance; the preparation of the bed for the ice to rest on; the necessity for good drainage; and especially the prevention of air striking into the bottom of the ice through the drain. These are some of the vital points of construction.

A very important branch of the railroad ice-house business is the icing of refrigerator cars for which purpose there are a variety of methods. Some simply take the ice out of the ice-house and push it on elevated platforms or slides to the top of the car to be iced. In other plants mechanical means are used not only for conveying the ice to the cars but for crushing it to the proper size. The committee report refers to the ice-house at Altoona, Pa. (Fig. 4), where there is a crusher and the crushed ice is conveyed to the cars in buggies, the power to run machinery being electricity.

Mr. Tanner.—In the several ice-houses built along the Missouri Pacific R. R., no sawdust is used for insulation. We found that the sawdust transmitted considerable heat that caused the ice to melt very fast. The sawdust also added to the decay of the studdings so that the house had to be reconstructed every seven or eight years. Most of the ice-houses built to-day are patterned after and built on the principle of the refrigerator car, using a double system of studdings. We make a good air-space, with sheeting boards and roofing felt two or three-ply thick, and

well put on both inside and outside of each set of studdings, weather boarding the outside. This gives good satisfaction and the ice melts but little. A batter of about one foot in 22 feet is used in most cases.

Mr. King.—In addition to what Mr. Carmichael and Mr. Bishop have said concerning ice-houses, will state that the one Mr. Bishop referred to is the same as the one we use on the Union Pacific. We have a slope in the floor as well as the batter on the sides, and I think that has a good effect, as the ice then settles to the centre. I think that is even as important as the batter sides. The slope is from each side to the centre, dropping about twelve inches, and at the centre we have a drain trough which slopes from one end to the other terminating outside the building, that is trapped in such a way that the air cannot enter the drain trough and be transmitted to the ice. It has been a question with us whether it is better to use air-space or not, and in the last ice-house we built, we have abandoned the idea of air-space. We built an ice-house at Evanston last fall having a capacity of six thousand tons. We used 2 x 8 studs, lined on the inside with good flooring, and space between was filled with sawdust. We then sheathed it on the outside of the studs, and covered it with tar-paper, and sided it up with drop-siding. The flooring on the sides is carried up to and on the underside of the rafters which leaves an air-space under the roof. The cornice is disconnected with the point where the side-walls meet the roof leaving a space of three or four inches which allows for ventilation. We also have raised ventilators at intervals in the roof. In the last ice-house we built, these spaces were closed up so that they are without air-space, but I do not know that the ice has kept any better.

Mr. Yereance.—What is the percentage of loss of the product considered to be in a house having no further insulation than one space filled with sawdust? Also, if the bed is built sloping towards the centre, is a batter necessary in that case?

Mr. King.—I am not able to say what percentage of loss is. The supply department on our road takes charge of the product when the ice-house is filled, but I understand it is hardly perceptible. I think the batter on the sides assists the slope in

the floor to keep the ice towards the centre as each successive tier of ice is drawn in just that much whatever the batter is, and the tendency would be for the succeeding courses to settle towards the centre and away from the side-walls.

Mr. Berg.—In regard to the slope in the floor, I have always considered that was a proper method on which to design an ice-house. In regard to the side batter, it will force the men filling the ice-house to draw in each successive tier of ice, as Mr. King has correctly remarked, but I would not necessarily on this account advocate or consider the side batter essential. In a large and extensive building it is desirable to keep the construction square. Proper supervision in the methods of packing the ice in the interior, drawing in the tiers as the ice increases in height, will accomplish the same results as if the sides of the house are built with a batter. In regard to the percentage of loss or shrinkage in an ice-house, I had occasion to collect data on that subject a number of years ago and found, from statements of the men in charge of ice-houses on the Lehigh Valley R. R., that in a brick ice-house at Mauch Chunk, Pa., the shrinkage was about ten per cent. per year. Further, in a frame ice-house at Phillipsburg, N. J., with only an 8-inch air space in the walls, the shrinkage was from 25 to 30 per cent. per year, but after the air space was filled with sawdust, the shrinkage was reduced to about 15 to 20 per cent. The brick house is in a gorge along the side of a mountain and gets very little sun, while the frame house mentioned stands out in the open exposed to the sun all the time. The apparent result of the figures I have quoted, would seem to indicate that air-space was inferior to sawdust. But, as usual, there were other attending circumstances making it hard to establish reliable deductions. At the time the sawdust was put in, the house needed repair badly, and was generally fixed up and especially ventilating sashes put in at different points of the sides of the building, so that in cold weather and on cool nights a current of air could be directed through the top of the house and reach all the foul, close air even when the ice was well drawn down, which I think helped to reduce the shrinkage.

Mr. Hanks.—Our company has five large ice-houses, two

batteries each of 12,000 tons and upwards, which are constructed with the batter studding, the perpendicular studs are double-matched sheeting with building paper between the outside studding, battered 4 feet in 25- and 30-feet walls, with novelty siding on the outside stud; 4 feet of Jumbo cinders for intermediate filling to keep out air drifts, which are very likely to occur at the bottom more than elsewhere. For the flooring of the ice-house, I find we have best experience with 1-inch rough maple on Jumbo cinders than anything else. The rafters are sheeted on lower side and packed with marsh hay, a good protection from the sun's ray where five and six roofs join together. Our percentage of waste is about one course on the flat. If any more than that, it would be in imperfect work in taking out and loading.

Mr. Yereance.—This subject of the waste of the ice in the house has worried us a great deal. We have packed it in almost every conceivable way, and we have tried all the various methods of storing. We have not got a "standard" house on the road to-day, and, in the light of the information we get from the transportation and traffic departments, we have about concluded, as the report states, that the question of "standard section" merits more attention than would at first seem necessary. I have never seen asbestos used, but a member suggested it. It is an inorganic substance instead of organic; but what the result would be if placed between the studding in improved insulation is not within my knowledge.

Mr. Berg.—There is another feature I would like to call attention to in connection with ice-houses. There is a tendency on all railroads to encourage the home manufacture of appliances for handling materials, etc., and frequently considerable moment is made of some home manufactured article and many claims made as to the resulting economies. As a rule, the true first cost is never actually known as the expense account in shop or the labor of the gang is not properly kept. The subsequent operating expenses are not properly analyzed and *ex parte* statements of the savings produced are accepted as facts. I am a strong believer of going into the market and getting the most improved special appliances for handling ice. Get some-

thing from a well-known firm of specialists rather than rig up some home-made article, of course using judgment in the selection and naturally only where the size of the plant warrants special contrivances being introduced. I refer to the various methods, machinery, and fixtures for filling an ice-house, handling ice in and out, crushing it, etc.

There is another very important question that the committee went into very extensively, and the chairman, Mr. Yereance, deserves credit for handling this branch of the subject so exhaustively. I refer to articial ice plants. It may not be an every day occurrence for our members to be called on to give their views on this feature of the icing business and yet none of us know what we may not have placed before us any day by our superior officers. Some years ago, I had occasion to study up the artificial ice business, partly in connection with a contemplated plant. I visited a great many plants in the country and came to about the same conclusion as the committee has reached, namely, that in many places, especially in southern sections of the country, it would pay a railroad company to go into the artificial ice manufacture provided the output required by the company is sufficient to warrant it. In the recommendations that I have made heretofore in published articles on the subject of ice-houses and in other reports, I have always emphasized, however, the important feature, that such business should be conducted by an auxiliary company closely connected with the railroad company, but not distinctly run under a railroad department. The works would then be conducted on a truly commercial and industrial basis, and neighboring settlements and outsiders could be supplied with ice, thereby enlarging the daily output and thus diminishing the unit cost. If handled in this manner, it would prove a source of revenue and give the railroad company much cheaper ice in southern sections of the country than they could get in any other way. I simply wanted to call attention to this valuable feature of the committee report, which was apparently being overlooked, and to express my conviction that it would frequently pay railroad companies to look into the matter of manufacturing ice.

Mr. Eilers.—We have in some of our houses a slope in the

floor, but do not find it much of a success. We are now building our houses with 2 x 8 studding, and using sawdust between the inside and outside lining. My opinion is that the straight ice-house instead of with a batter is preferable. We have at Ottumwa two large ice-houses and we store a lot of ice for our freight trains, passenger service, and in fact for everything else, and find them a great deal more advantageous than with a batter. In regard to rods through the houses to hold them; we put our rods up above and keep them entirely clear of the ice, so that there is no fear of the ice spreading the house out. I find that we have had no trouble at three or four of our division points in regard to this.

Mr. Cummin.—Mr. President, Mr. Pierce is present, who is not a member of the association, but who has had experience in insulation in connection with refrigerator cars.

President.—We will be glad to hear from Mr. Pierce.

Mr. Charles F. Pierce.—My experience has been gained through comparison of one house with another, and in many different territories and climates. The temperature at which you store ice in an ice-house, has much to do with the ease in which you get it out, and ice stored at 20 or 25 degrees above zero is much more easily removed from the house than when stored at 10 or 15 degrees below zero. The keeping qualities of the ice depend very much on the different methods of insulation and the climate. Storing ice in Southern California, or in southern states, is very different from storing it on the Michigan Peninsula, whether saw-dust, cinders, shavings or air-spaces are used. All give different results, according to the quantity of air confined in the air-spaces, and the different materials mentioned above will give good or bad results, as non-conductors of heat or cold, according as they confine the air in the spaces. A good 3-inch air-space, with the air well confined, is as good as 12-inch. The most serious test we have is the keeping of fruits. Where we have good air-spaces, we can protect the fruit all the way from three to eight days, even as far north as Ishpeming on the Northwestern road and even in extreme climates. I find the different materials give different protection. Sawdust is good when it is fresh and dry, but if it is

soggy and wet, it loses value and becomes a conductor of heat. The more air space you can get round your ice-house, the better the ice will keep. We have often followed the suggestion of an air-space outside, both on the sides and roof of the house, which is so arranged that the air can circulate through. The same rule is applied by the Southern Pacific Ry., having false roofs over their cars and structures, so that the sun does not so easily penetrate to the building.

Mr. Cummin.—My own experience with ice-houses has been rather limited. We have none on our road, contracting for all of our ice from an ice company. But I had a little experience some twenty odd years ago, while I was contracting, that has led me to believe that sometimes the greatest mistake you can make in building ice-houses is laying out too much money on the house. I was called upon by an ice-cream manufacturer to build an ice-house on the shores of a large lake, and he described to me the manner in which he wanted the house built. At first I positively refused to have anything to do with it, but he kept after me, and I finally agreed to build it. We built it with 6-inch studding, siding it on the outside with rough hemlock boards and lined it on the inside with the same material, and on the inside of that we built a rack eighteen inches inside of the lining of 1¼ x 2-inch spruce, and he stuffed that with salt hay from the salt meadows. The roof was an old-fashioned thatched roof, similar to the old ones you see on houses in the old country. The rafters were three feet centres, 1¼ x 2-inch strips, nailed on 10-inch centres and the thatch fastened to these strips with marlin. To use an old phrase it was not a thing of beauty, but to the ice-cream manufacturer, it was a joy forever. I built several ice-houses for wealthy gentlemen after that on plans furnished and on which a great deal of money was expended. My opinion is that none of them kept the ice as good as the one built for the ice-cream man. I think a double roof is the main thing in an ice-house. It gives a current of air passing over between the two and keeps the heat away from the roof adjoining the ice.

Mr. Staten.—We have a number of ice-houses on the Chesapeake & Ohio. They are built with 6-inch studding and

lined up with plank on the inside and rough sheathing on the outside. We then fill in with sawdust up to plate, ceiling under rafters, thus making an air chamber. On the outside we put on another strip and then weather boards on that, making another air chamber. Our purchasing agent arranges with some contractor to fill the ice-house every year. We do not keep a very large stock on hand, but send out to the factory and have some more made and the house filled up again. In that way we do not give it much chance to melt. Nearly all our houses are filled in that way and consequently we have not much trouble with it melting.

Mr. Berg.—Regarding the sawdust versus air-space, or any other kind of a filling versus air-space, I think we can learn a great deal from the packing-houses and abattoirs, where the refrigeration question is of such heavy moment. Where they have to create artificial cold, they certainly desire, after getting it, to take care of it. I believe I am right when I say that all designers of such structures invariably use air-spaces instead of filling with sawdust or any substance of that kind for the reason that Mr. Pierce has mentioned, that when the sawdust becomes wet it becomes a conductor of the heat from the outside; and in addition to that it decays the timber with which it comes in contact. I have personally always considered that air-spaces are preferable. The introduction of an independent rack on the inside of the house and filling between the rack and the sides of the building, as mentioned by Mr. Cummin, with some suitable material is good practice.

Mr. Isaacs.—I believe the proper method of insulation for an ice-house is with sawdust packing with an air-space outside. We know that dry air is a non-conductor, but that moist air free to move is a pretty good conductor of heat. It is almost impossible to get an air space next to the ice and keep the air dry.

Mr. Montzheimer.—We have no ice-house at Milwaukee. The ice is delivered in cars by contract. Originally, the ice was broken on the freight platform and pulled to the top of the refrigerator cars by ropes. Last summer we built a short trestle to hold two cars of ice. This brought the floor of the ice cars

level with the top of the refrigerator cars. The ice is then slid along the top of the refrigerator cars to the ice tanks. We ice about fifteen or twenty refrigerator cars every day and three men can do it in two or three hours, where formerly it took twelve men all day and then they were in the way of the freight handlers. The trestle cost about $185 and is a good paying investment.

Mr. Charles F. Pierce.—In order to have fruit come through in condition from California to New York in extreme weather, it is necessary to have air-spaces that can be called such. A confined air-space is not a confined air-space unless it is a confined air-space, which it may be unnecessary to state. If the insulation is good, the confined air in the first air-space next to the air where sawdust is used, will be more moist than the air in the outside space. The air in the outside space should be protected from the moisture of storms, and the heat from the direct rays of the sun, in order to protect the air and temperature of the rooms in which the goods are stored. We find, by long experience, that good insulation, with confined air-spaces, gives us the best results.

Mr. Isaacs.—If you have no means of allowing the sawdust to drip and let the moisture accumulate, it will be a conductor of heat, but if holes are bored in the sill to take the drip from the sawdust, and you keep it comparatively dry it will be a fairly good non-conductor.

Mr. Yereance.—If the sketch of the Standard Ice-House Section recommended by the committee (Fig. 2) is examined, it will indicate how moisture or dampness of the air in the insulating spaces can be cheaply overcome when the job is properly done, as each air-space can be made air- and water-tight. That means that the air will be kept dry.

VI. Best End Construction of Trestles Adjoining Embankments.

REPORT OF COMMITTEE.

To the Association of Railway Superintendents of Bridges and Buildings:

Gentlemen:—Your committee on subject No. 8 beg to submit the following as is in their opinion the "Best End Construction of Trestles Adjoining Embankments":

First. The end bent should be piled and consist of not less than four piles well driven, and properly spaced.

Second. The bulkhead should begin about one inch below the base of the rail, conform to the slope of the embankment and extend below the tops of the piles.

Third. The embankment at the end of the trestle should be made of such material obtainable as will shrink or settle the least.

(a) The piles in the end bent are called upon to bear not only one-half the load on their span, but also the shock of on-coming trains. Could the embankment be kept up to its proper height, there would be no trouble from the latter cause. Since there is more or less yielding to the embankment, trains crossing a trestle act like so many pile-drivers on the end bent, and the resistance of this bent gives the train the jolts so familiar to all. On this account, where all piles in a trestle have been driven to a uniform bearing, if any settlement takes place afterwards, it usually occurs first in the end bents. The piles in the end bents should, therefore, wherever practicable, be long enough to go through the embankment and be driven to solid bearing in the ground beneath, and deep enough to guard against any possible danger from scour from the stream which the trestle crosses.

As the end bent is called upon to do the heaviest work, it follows that its piles should be spaced so that each one will be uniformly loaded. We condemn the use of a three-pile bent for any but temporary work. It is rarely sufficient for the end bent and its worst feature is, that the giving away of any one pile is apt to cause the whole bent to fail. Trestles of this kind are particularly dangerous after they begin to rot.

(b) The bulkhead should be as wide and conform to the slope of the embankment for obvious reasons. Separating it from the trestle by furring strips, and extending the bulkhead below the tops of the piles, are for the purpose of keeping the ends of the stringers and tops of the piles from decaying, by having a free circulation of air around them. An air-space of less than two inches is apt to become clogged by earth or other material lodging in it. We prefer an air-space of not less than three inches. Where the bank is more than six feet high, one extra pile should be driven on each side of the track to hold the ends of the bulkhead from being crowded in by the embankment, and dependence should not be placed in the bolts through the stringers and cap to keep the end bent from being pushed out of place. Struts should be used from the cap of the end bent to the second bent, preferably to its piling at their ground line.

If planks are used for the bulkhead, a brace should extend on each side, from the end of the ties to below the outside ends of the bottom plank, to which the ends of the bulkhead planks should be spiked.

(c) We have already touched upon the necessity of keeping the embankment up to its proper height, hence the reason for using material that will shrink or settle the least, at the end of the trestle.

Sufficient berm should be left at the bottom of the bulkhead to prevent the embankment from being undermined. Where the embankment is new, it is well to let the trestle extend temporarily one span beyond its final length over the embankment and rest it on mud sills, the extra span to be taken out when settlement has ceased.

We append herewith plans, illustrating points brought out in our report, from the following railroads: D. S. S. & A., C. & N. W., S. P. Company, C. M. & St. P., P. F. W. & C., D. & I. R. R.

Respectfully,

C. C. MALLARD,
W. S. DANES.

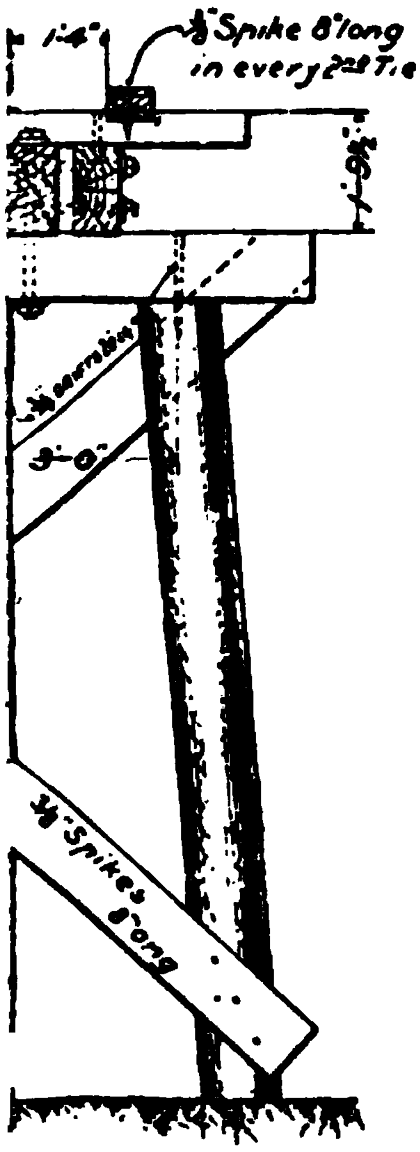
DISCUSSION.

Mr. Mallard.—I have nothing further to add to the committee report excepting that we furnished the plan of the Southern Pacific company, and you will note that there is no air-space left between the bulkhead and the rest of the trestle. This was not considered necessary because we use creosoted timbers and they are impervious to water and will not rot.

Mr. Strain.—For a protection of the end of trestles, I am in favor of extending the dump bent well into the dump. After doing so, I think the bulkheads should be brought down below the bottom of the cap, and a 3-inch block be placed between the end of the stringers and the head block. This protects the cap, and also prevents the dirt from coming in contact with the stringers. We use that method on the Middle division and find it works very satisfactorily. Where we shorten up a trestle, we put in head blocks low enough to prevent the water washing from under them. We drive 4 piling in the dump bent and make it a point to get the largest piling for that purpose.

Mr. Carmichael.—We build a neat and lasting bulkhead at the ends of our trestles. We saw the stringers off flush with the outside of the cap and set up 3-inch furring strip. Then build in 3 pieces of 7 x 15 inch pine on edge, one above the other, making bulkhead 3 feet 9 inches high. This reaches from the base of the rail down 6 inches below the bottom of the cap, and forms an air-space of 3 inches between the bulkhead and end of bridge proper. This 7 x 15-inch is old bridge stringers. We bolt the bottom piece of the bulkhead to the piles and cut the ends on a mitre. A bulkhead of this description will last as long as the bridge top and is always up in shape.

RAWING Nº 2548.



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CHICAGO, APRIL 1893

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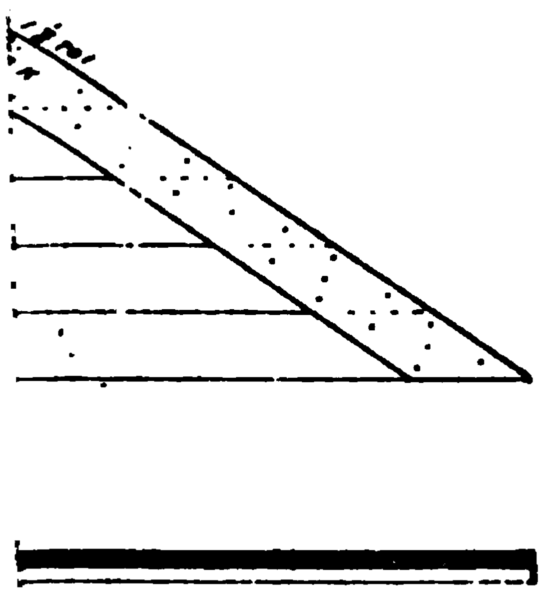


PLAN

Fig. 13.—End Construction for Trestle Adjoining Embankments, Duluth & Iron Range Railroad. (Committee Report on "Best End Construction of Trestles Adjoining Embankments.")

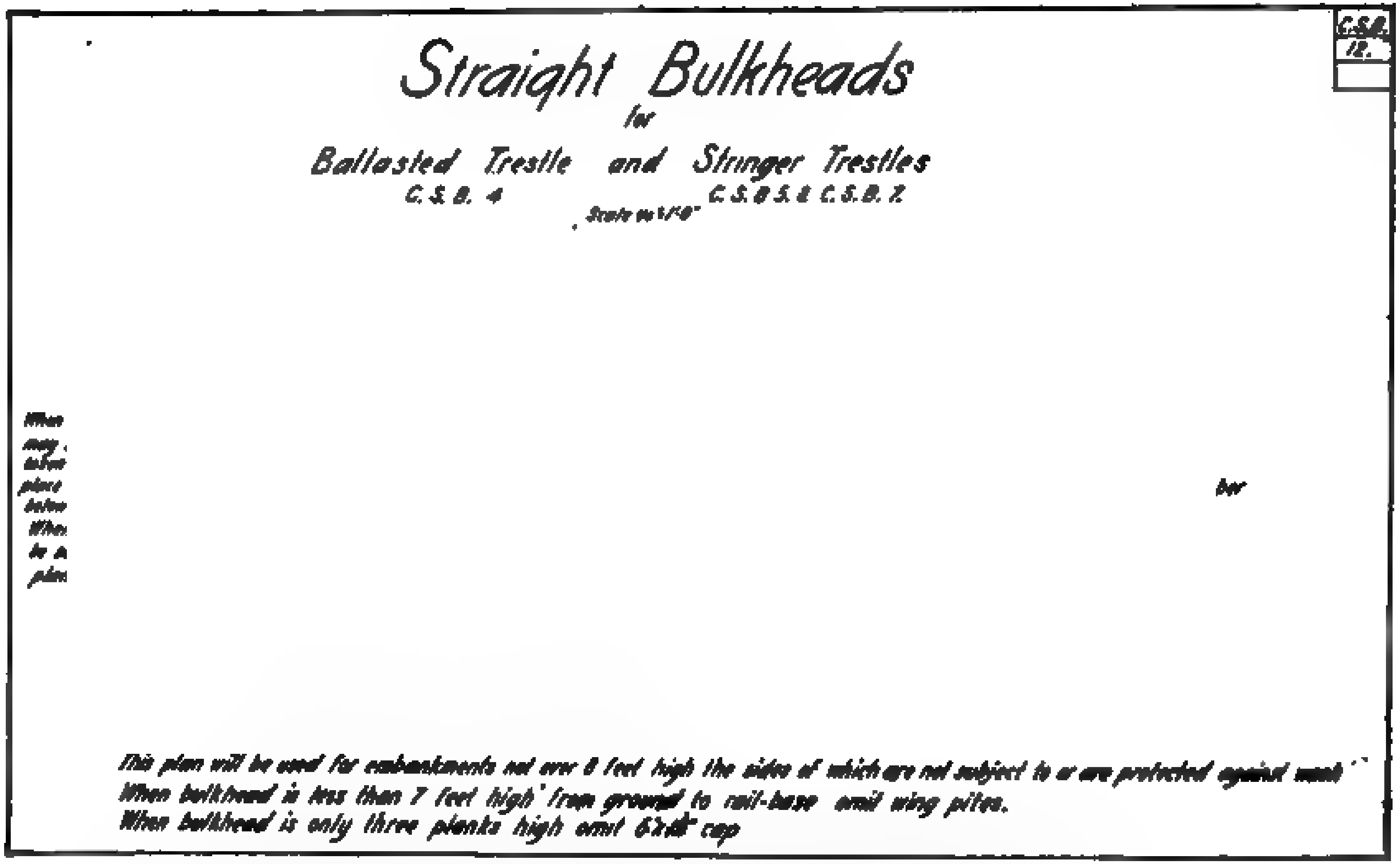


FIG. 13a.—Straight Bulkheads for Ballasted Trestle and Stringer Trestles, Southern Pacific Railroad. (Committee Report on "Best End Construction of Trestles Adjoining Embankments.")

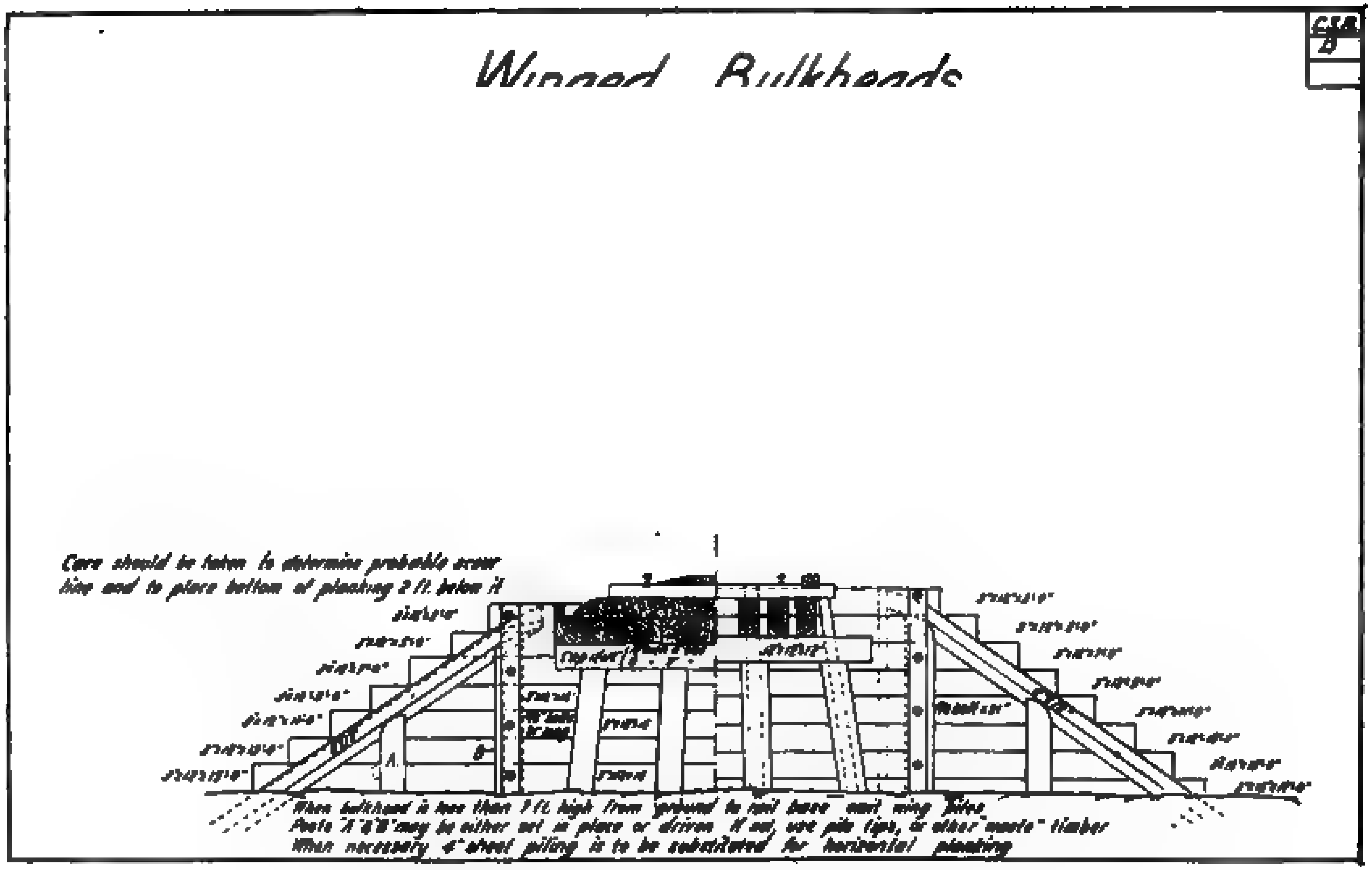


FIG. 18 b.—Winged Bulkheads for Ballasted Trestles and Stringer Trestles, Southern Pacific Railroad. Committee Report on "Best End Construction of Trestles Adjoining Embankments.")

Mr. A. McNab.—On our system nearly all our pile and bent trestles are filled so as to have a natural slope. We let the stringers project 6 inches over cap, cutting them off square with track, and spike grade plank on the ends of stringers. We generally use 2 pieces—3 x 12 inches—16-feet pine for grade plank. The lower edge of grade plank is 4 inches lower than bottom of stringer. We leave no air-space between stringer and grade plank.

Mr. Bishop.—Our system is similar to Mr. McNab's.

Mr. Riney.—Our system is the same as has been explained. We have a 3-inch air-space between the bulkhead and stringers.

Mr. Mallard.—We brought out in the committee report the point that where the bulkheads were over six feet piles should be driven on the shore side. Some provision should be made for keeping the bents from turning over.

Mr. Carmichael.—In the end construction of our trestles, where the dumps are 6 feet high, we bolt a chuck-block on the bottom side of the jack-stringer close up against the cap. If the dump is more than 6 feet, we put 3 struts between the dump cap and the next cap ahead and bolt the chuck-block on the jack-stringer at the second cap. This gives us two bents to hold the dump pressure. We find this very satisfactory.

Mr. Staten.—We have nothing of the kind on our main line, but on the branches we have trestles, and since I have been connected with the road we have renewed many of them. We use stringers, 8 x 16, 10 x 12, and 12 x 12. We generally leave six or eight feet end panel and put the timber right behind bent at whatever slope the fill would be, and frame that right up to the top against the rails. Where the piece goes across in front just have it the width of the roadbed and outline the slope of the fill till you come up to the top. And, if there should be any pressure, it will be on crib instead of bent. We always try to use the old timber and make it as neat as we can, sloping it to suit fill.

Mr. Zimmerman.—On the Union Pacific, Denver & Gulf, our plan of fixing ends of bridges is the same as used on the Union Pacific system.

Mr. Mallard.—In coming here I passed over various systems

where they had put in old stringers, many of them the same length and many of a variety of lengths to hold the bank, and at some places fence rails were put in at the corners. In our committee report we recommended that the slope should conform to the slope of the bank, for appearance if for nothing else.

Mr. Eggleston.—We drive a six-pile bent, four piles for track and two for bank. We put our bulkheads down four feet below the actual bed of the stream to save washing or undermining. We build the bulkhead up according to the slope of the approaches. If we have old timber we use it, and if not we use 6 x 12 plank for bulkhead.

VII. Bridge Warnings for Low Overhead Structures.

COMMITTEE REPORT.

To the President and Members of the Association of Railway Superintendents of Bridges and Buildings:

Your committee on the subject "Bridge Warnings for Low Overhead Structures" present the following report:

There seems to be no doubt of the necessity, and we have found no tendency on the part of any one to dispute the value, of giving warning to railroad men on top of cars, of the fact that the train is approaching some overhead structure or tunnel, with less clearance than requisite to clear the tallest man standing on top of the highest car. A number of appliances for giving such warning are used on railroads and are known by a variety of names, such as bridge warning, bridge guard, tickler, tell-tale, whip guard, bridge indicator, bridge detector, bridge alarm, and bridge signal.

The general principle remains the same in all cases, namely, some appliance is suspended or swung over the track near the obstruction in such a manner and at such a height as to strike a man a light blow and thereby give warning that a low bridge, tunnel, or other overhead structure is being approached.

There are two radically different systems employed to accomplish the results desired. The system that is most extensively used, and which for convenience will be designated as the "vertical rope system," consists of having light vertical ropes or wires (known as tell-tales, whip-cords, ticklers, or danglers) suspended over the track from a rigid horizontal wooden or iron bar or hung from a flexible wire or cable, the bar or cable being suitably supported on the outside of the track or tracks by upright posts set in the ground and properly braced and backstayed. In the other system, called frequently the Walling system, from the name of the leading patentee, and which can be designated as the "swinging arm system," a light horizontal swinging arm is projected out from a post planted on the outside of the track so that the arm will strike a man on top of a car, but at the same time swing out of his way as he passes on and then return automatically to its original position again.

It can be stated at once that the swinging arm system requires a separate arm for each track to be protected and further a separate post for each track, unless a post is set between tracks with arms on two sides. In the vertical rope system, any number of tracks can be crossed and the posts kept clear on the outside of all the tracks, the only question involved being to give the supporting bar or cable the proper stiffness, and to backstay or brace the end posts sufficiently to resist the inward pull at the top.

Further, the testimony of the use of the swinging arm system on the Boston & Maine R. R. and on the Lehigh Valley R. R., indicates that it is not always safe. It has to be hung very delicately so as not to hit too hard a blow when struck, but in consequence, high winds affect it and blow it out of position. It can also be said that there is no positive assurance that in northern climates the pivoted joint connections will not become frozen and hence the apparatus dangerous under such conditions. Further, it is very easily damaged by trainmen striking it with brake-sticks or by swinging it around with great force or catching hold of it when passing slowly under it.

There are other similar arrangements, in which light horizontal arms are counterweighted or variously arranged, but they have similar objections to those just mentioned.

Your committee is forced to consider that the vertical rope system, as it has been designated above for briefness, is the best under most

circumstances. There are numerous modifications of it in details, but the general principles remain the same.

It will prove desirable to mention briefly some of the most important characteristics and practical features that should be considered in the design of a bridge warning.

Probably a very vital consideration is low first cost combined with durability. In this latter respect the iron tube supports and overhead bar used by the Southern Pacific Ry. are very advantageous, while the preservation of timbers by chemical means on all roads having facilities for such work within reach will also prove a saving in the long run. As the material is standard stock, it can be framed and treated in large batches at a time and placed in stock. Of course, a very low first cost can be obtained by adopting very crude arrangements, but it is a question whether possible damage suits for accidents resulting from imperfect structures will not far outbalance the slight additional cost of a suitable construction in the start.

According to the data collected by your committee, bridge warnings seem to cost from $8.00 to $25.00, for a single track, and from $20.00 to $30.00 for a double track warning. With a cable support, a large number of tracks can be crossed with comparative ease and small additional cost over that of a double track warning. One member places the extra cost as only five cents per lineal foot. For an improved system using some means to prevent the ropes from catching on the cable, the probable extra expense would be from $3.00 to $5.00 per additional track over the cost of a double track warning. The standard iron tube frame bridge warning of the Southern Pacific Ry. costs $25.00 complete for a single track.

In regard to the tell-tales, ticklers, or danglers, the usual construction is to use ropes, from one-fourth to three-fourths inches in size, knotted at the lower end and suspended from short pieces of wire or flat iron loosely or rigidly connected to the overhead bar or cable. In some cases the ropes are attached directly to the overhead bar or cable. It is a mistake to use too large a cord and especially a big knot at the lower end. In winter, ice will collect to such an extent that it is positively dangerous for a man to be hit by the end of one of these ropes. Rubber straps, sash cord, or old bell cord is frequently specified. On the Lehigh Valley R. R., the practice is to untwist old heavy rope and use one of the strands, which is economical and makes a softer rope. Some designs show wire or steel tape danglers, but this feature does not seem a good one, on account of rust and greater danger to men.

The ropes are generally spaced from four to eight inches apart for a distance of five to eight feet across the track. The lower ends are usually specified to be six inches lower than the lowest point of the overhead structure for which they are to give warning, or a standard height of from sixteen to seventeen feet above the rail is specified.

One of the important features is to prevent the ropes from being blown by winds or the engine exhaust, or more particularly from being tossed up by trainmen in such a way as to remain hanging on the top frame or bar. This is one of the most usual objections to the danglers. It can be overcome in a number of ways, several of which are indicated in the plans accompanying this report. The arrangement shown as in use on the Chicago, Rock Island & Pacific R. R., namely, a horizontal hood over the top of the horizontal bar above the tell-tales, has the great additional advantage of protecting the ropes to a certain extent from the weather, and hence less liability to freeze and become stiff and hard.

In regard to the location of the warning with relation to the bridge proper, it should not be too far away, as there is too much chance for

a brakeman to rise up on the car between the warning and the bridge. Various distances of from 200 to 300 feet are specified, and in one case one quarter of a mile is mentioned. The distance should certainly be limited to about 200 feet, and in yards where much switching back and forward is done immediately under an overhead bridge, the location should be closer, or even a second warning put up.

Most roads seem to specify that bridge warnings shall be used at all overhead obstructions with a less clearance than twenty feet, although the range runs from eighteen feet, six inches to twenty-two feet.

An important maintenance feature is to arrange that the danglers can be easily repaired if torn off, tied up, or knotted together by brakemen standing on cars temporarily halted under the warning. The usual method of having a car hauled under the warning and workmen climb up on horses on top of the car is so cumbersome, especially out on the line, that it is put off from day to day, thus taking many chances with the life of the trainmen at night. The other system of setting up a ladder is equally objectionable. A tell-tale frame that can be let down, or if hung to a cable some arrangement to lower the entire cable, is generally preferable. It must be, however, practicable and guarded in such a way that tramps and unauthorized parties cannot tamper with it. Mr. W. B. Mitchell, of the Erie R. R., reports that he uses a small windlass locked in a box on the side post near the ground. The tell-tales are suspended from a cable, one end of which is wrapped around the drum of the windlass. When required, the cable is let down and after the repairs are made, hoisted into place, and a strain put on it. Special attention is directed to the device used on the Chicago, Milwaukee & St. Paul Ry., known as the "Nettenstrom Signal," which is giving good service, as per report of Mr. Onward Bates.

This is one of the advantages of using a cable, and it has also the advantage that a large number of tracks can be spanned with it. But it has the disadvantage that it is liable to sag badly and requires good backstaying and bracing of the side posts.

The effort to counteract the ruling passion of brakemen to show their agility by climbing up on bridge warnings when a car stops temporarily under one has produced numerous arguments for and against a rigid overhead construction. If made rigid, no serious harm will be done, while on the other hand, if not able to support the weight of a man there will be less temptation offered, but more damage done if the feat is attempted. This is a double-edged question that your committee will not attempt to settle.

Comparing the single post frame and a double post frame for a single track warning, it can be said that the single post can only be used where there is an opportunity to bury the foot well in the ground or otherwise thoroughly brace it. Where this is not feasible, a post each side of the track should be used. Further, a double post warning can be more readily and quickly framed and put up on the ground, whereas a single post frame with projecting arm requires more carpentry work, that should preferably be done in a shop, and the post has to be set with greater care in reference to the track and much closer to it.

We present in an appendix descriptions and illustrations of a large variety of bridge warnings and information kindly contributed by members of this Association in response to the circular of inquiry sent out by the committee.

W. E. Harwig,
M. A. Martin,
Joseph Doll,
Committee.

APPENDIX TO COMMITTEE REPORT ON "BRIDGE WARNINGS FOR LOW OVERHEAD STRUCTURES."

DESCRIPTION OF BRIDGE WARNINGS FROM DATA FURNISHED BY MEMBERS OF THE ASSOCIATION.

Erie R. R.:—Uses for single track a one-post "Bridge tell-tale" with ropes suspended over track, as shown on Plan No. 1. Mr. W. O. Eggleston states the cost is $16.72 for one warning.

Wabash R. R.:—Uses for single and double track a two-post "Bridge warning" with a wooden cross-bar from which the ropes are suspended, as shown on Plan No. 2.

Chicago, Rock Island & Pacific Railway:—Uses on the lines west of the Missouri river, for single track a two-post "Bridge tell-tale" with wooden cross-bar from which the ropes are suspended, as shown on Plan No. 3. Mr. George J. Bishop states that while the design is similar to other bridge warnings there is one very good and novel feature about it, namely, a hood, 7 ft. 8 in. long and 5 ft. wide, above the ropes. Trainmen and the exhaust from the engine cannot throw the ropes so as to cause them to hang on top of the cross-bar. The cost for one single-track bridge warning is for material, $12.26, for labor on construction, $6.67, for labor in erection, $7.50; total cost, $26.43.

Pennsylvania Company:—Uses a one-post "Bridge alarm" with one-half inch ropes hung to one-fourth inch rods run directly through the top cross-arm, as shown on Plan No. 4. Mr. N. W. Thompson states that he generally makes the ropes 2 ft. 10 in. long and the rods the same length, and then sets the post so that the ends of the rope are six inches lower than the lowest point of bridge. The ropes should not be longer than the rods or they will catch and hang on the cross-arm. These bridge alarms cost from $15 to $18, in position.

New York Central & Hudson River R. R.:—Uses for several tracks the system shown on Plan No. 5, namely, ropes suspended from a wire cable stretched across the tracks between two side posts. For a single track the standard "Bridge guard" is a one-post structure, as shown on Plan No. 6. The timbers coming in contact with the ground are painted thoroughly with a preservative fluid called "Carbolineum Avenarius."

West Shore R. R.:—Uses a one-post "Bridge guard" practically the same as shown on Plan No. 6, with the additional feature that on top of the cross-arm there is a board two feet high and eight feet long set up on edge, which board acts as a fender to prevent the ropes when thrown up from hanging on the cross-arm, which accomplishes the same result as the wire-netting frame used in other designs below the cross-arm, as shown, for instance, on Plan No. 9. Mr. W. B. Yereance says this bridge guard costs $10 at shop, and can probably be erected for about $2.50 to $3.00.

Chicago, Milwaukee & St. Paul Railway:—Uses the "Nettenstrom Signal," as shown on Plan No. 7, for a double-track warning. The arrangement for a single track is similar to that shown in the plan,

excepting that the heads of the side posts are connected by 2 in. x 6 in. x 18 ft. top bar with 2 in. by 6 in. knee braces. The chief feature of this design consists in the ease with which the supporting one-fourth inch wire rope can be lowered in case repairs are required. The ropes are one-half inch round duck belting, four feet long, and are spaced on a rod attached to the wire cable by three-eighths inch rubber hose with washers. Mr. Onward Bates states that this type of bridge warning has been in use on the Chicago, Milwaukee & St. Paul Railway for the past three years, and has proved much more satisfactory than the warnings used previously. The cost of a set of strips hung on the rod ready for use is about $3.25. The cost of poles, sheaves, wire rope, and the erection will of course vary according to circumstances, but the usual estimate for a single track warning erected is $20.

Boston & Maine R. R.:—Has a number of different designs for "Bridge guards" in use with one-post and a wooden cross-arm from which ropes, rubber straps, wires, or steel tapes are suspended over the track. There is also a design in which light wooden slats, 1½ in. x ½ in at top and ½ in. x ½ in. at bottom, are strung on a telegraph wire stretched across the track from the top of posts. Mr. J. P. Snow states that the design, shown on Plan No. 8, and designated by him as the "Walling bridge guard," is the one that is now generally used on the road. It is more durable than most of the others and is quite inexpensive. The warning made with flat steel tape is very cheap, and in some places gives good satisfaction, but on his road the tapes rust out in a very short time, from the blast of the engines. Wires and straps are apt to be thrown over the bar by the brakemen and hence rendered ineffective. The guard made with a light horizontal bar counterbalanced with a ball on the rear end has been used quite extensively, and works well when it is not out of order. The Walling bar is much less liable to get out of order, and is effective except in case of a very high wind.

Southern Pacific Railway:—Plan No. 9 shows the wooden frame standard "Low bridge warning" and a more recent standard with boiler-tube frame, the latter being used exclusively at present on the Pacific system of the road. Mr. John D. Isaacs states that the cost of the boiler-tube frame warning for single track is $25, in place, all charges included. Also that it is best to make the wire screen with diagonal mesh, as shown on the plan, otherwise the cross-beam will sag.

Cleveland, Cincinnati, Chicago & St. Louis Railway:—Uses for single track a one-post "Bridge alarm," similar, as far as the post and cross-arm are concerned, to Plan No. 4, and with ropes suspended from a wire-netting frame hung to the cross-arm, similar to Plan No. 9. The bridge alarm is to be used for all structures with less than twenty feet clearance above rail, and to be placed not more than 200 feet from the structure. The bottom of the "danglers" to be at least six inches below the lowest point of structure. Woodwork to be of white pine. Timber below ground tarred, above ground painted black. Post, 8 in. x 8 in, chamfered, and set in ground with cross-frame. Cross-arm, 13 ft. long, from 6 in. x 6 in., tapering to 3 in. x 3 in. The frame suspended from cross-arm is made of galvanized No. 12 wire netting, 1-in. mesh, 8 ft. 3 in. wide, and from 1 ft. 6 in. to 4 ft. deep, according to height of structure, the bottom of frame being set 21 ft. above rail. The danglers are made of cotton bell-cord, spaced 6 inches apart, and from 2 ft. to 4 ft. 6 in. long. The tops of cords are fastened to bottom of wire frame, and the ends are wrapped.

Cape Fear & Yadkin Valley Railway:—Uses a "Bridge guard"

almost the same as shown on Plan No. 4. The post is 8 in. x 8 in; the cross-arm is 5 in. by 7 in., tapering to 5 in. x 3 in., the top is set 20 ft. above the rail, and the length of arm is 13 ft. from the post. The ropes are spaced 6 inches apart, are ½ in. in size, and 2 ft. 6 in. long. They are suspended from ¼ in. wire rods, 2 ft. 3 in. long, run through the cross-arm. Mr. H. L. Fry states that this bridge guard costs $8.

Duluth, South Shore & Atlantic Railway:—Uses a "Tell-tale signal" similar to Plan No. 4. The ropes are ¼ in. in size, 6 ft. long, and the ends are 16 ft. above the rail. The ropes are hung from 3-16 in. rods, 2 ft. long, with eyes at both ends, fastened to cross-arm with staples. The side post is cedar. The cross-arm is composed of two pieces 1 in. x 12 in., tapering to 8 in., and 14 feet long, bolted to top of post, and braced with a plank brace.

Chicago & Northwestern Railway:—Uses a one-post "Whip guard" very similar to the Cleveland, Cincinnati, Chicago & St. Louis Railway standard described above, and also a two-post standard. In the one-post design the post is 10 in. x 10 in., set in the ground with a suitable cross with 6 in. x 10 in. x 10 ft. sills and 4 in. x 6 in. braces. The cross-arm at top of post is 2 in. x 8 in., tapering to 4 in., with a top piece 2 in. x 6 in. laid flat. The cross-arm brace is made of two pieces 1 in. x 6 in. The wire netting frame is 9 ft. x 2 ft., made of woven No. 14 wire, 2 in. mesh, galvanized. Binding and stiffeners, No. 5 wire. The frame is spiked to cross-arm. The ropes are spaced 4 inches apart, and are 4 ft. 6 in. long. The ends of ropes are 17 ft. 6 in. above rail. The warning is located 300 feet from the structure. The cross-arm is 17 ft. 4 in. long, and the face of the post is set 12 ft. 6 in. from the centre of the track. Mr. M. Riney says the warning is used for all structures with less than 22 feet clearance, and the cost of construction is for materials, $7.80, for labor, $6.00, total cost, $13.80. The two-post standard is very similar to the one described, excepting the side posts are round cedar, the cross-arm is 6 in. round cedar, spiked to top of the side posts and braced with a 1 in. x 6 in. plank. Space between posts, 17 feet.

Union Pacific Railway:—Uses a two-post "Bridge and tunnel alarm" with the ropes suspended directed from a light bar hung by two bolts to the cross-arm of frame, similar to the hanging of the tell-tale bar shown on Plan No. 1. The side posts are 8 in. x 8 in., set in the ground with a sill of two 3 in. x 6 in. by 14 ft. sticks on edge, braced with 6 in. x 6 in. sticks. Cross-arm 6 in. x 6 in. and 15 feet long in clear between posts. Knee braces two pieces 2 in. x 6 in., all bolted together with ½ in. bolts. Ropes are 3-8 in. sash cord braided and about 5 feet long, but made to come 6 inches lower than the lowest point of structure. The bar through which the ends of the ropes pass is 2½ in. x 2½ in. x 7 ft. long.

Chesapeake & Ohio Railway:—Uses a "Bridge and tunnel guard post" very similar to the one shown on Plan No. 4. The ends of the ropes are set 16 feet above the rail. The face of the post is placed 6 feet from the rail. The ropes are spaced 8 inches apart and are tarred ropes, 3 feet long. They hang on ¼ inch iron rods, 2 feet long, with eyes at each end. The rods hang on bolts put through the cross-arm. The cross-arm is 12 ft. 6 in. long, 5 in. x 8 in., tapering to 6 in. The knee brace is 5 in. x 6 in. The post is 10 in. x 10 in., set in the ground with 6 in. x 8 in. braces parallel with the track and a back brace square to the track consisting of two pieces, 2 in. x 8 in., bolted to the top of a dead post set in the ground.

Erie Railroad:—Mr. W. B. Mitchell states that on his division the standard "Bridge tell-tale," shown on Plan No. 1, is in use for a single-

track warning, and that it costs about $12. For a number of tracks he has in use a design in general similar to that shown on Plans No. 5 and No. 7. He states that the cost for one pair of side posts is about $20, and that the cost of the wire and tell-tales is about 5 cents per lineal foot span across the tracks. They have a warning of this construction at Urbana, O., over three tracks, and it has not given any trouble since it was put up, about four years ago. The side posts are yellow pine, 30 feet long, 10 in. by 10 in., tapering to 8 in. x 8 in. The cross at foot is made of two pieces of oak, 3 in. x 8 in., 7 feet long, at right angles to each other. There are four foot braces, 6 in. x 6 in., oak, reaching up 4 feet and out 3 feet. The face of post is set 8 feet from the nearest rail. The tracks are spanned by a ¼ inch wire cable, one end being fastened through the head of one side post and the other end attached to a small windlass near the ground on the second side post, the cable running over a small sheave at the top of the second side post. The windlass is enclosed in a box with the lid screwed down so that it cannot be tampered with. When repairs are necessary, the cable is let down very easily and speedily. There are twelve tell-tales over each track, spaced by pieces of gas pipe 5 inches long, and each set held on the cable by clamps at each end. The tell-tales are made of bell-cord, 2 ft. 6 in. long, fastened to an eye on the lower end of a 2 ft. piece of telegraph wire. The upper end of the wire is fixed tight in the rim of a small pressed iron washer that is strung on the supporting cable. Mr. Mitchell says that the cords when thrown up violently simply revolve around the cable and fall down again in their proper place and do not get hung on the cable. In spacing them with the gas pipe pieces, mentioned above, some play should be given, and the side clamps not pressed up too tight.

New Orleans & N. E. R. R., A. and V. Railway, and V. S. and P. R. R.:—Mr. T. Kelleher states that the standard "bridge warnings" in use on his railroad system cost about $25, complete in position. For single track there are two standards, one with a single post and horizontal arm for earth foundation, and the other with two posts for rock foundation. In both cases there is a wire screen, 2 ft. 8 in. x 8 ft., hung by three ½ in. hook bolts to the top cross-arm. The rim of the screen is ½ in. in diameter and the body No. 10 wire, with 1 in. square mesh. There are 17 ropes, ½ in. in diameter, 3 ft. 8 in. long, hung from the bottom of the screen. Ropes are spaced 6 inches apart, and are double-braided cotton, well knotted to screen, and ends bound. The face of the side post is set 8 feet from the centre of the track on tangents and 9 feet on curves. The ends of the ropes are placed 17 ft. 10 in. above base of rail. In the single-post standard, the cross-arm is 3 in. x 8 in., braced to post by two pieces 3 in. x 6 in., and bolted with ⅝ in. bolts. The post is 8 in. x 8 in. and set 5 feet in the ground, with 3 in. x 10 in. and 3 in. x 6 in. sills and cross pieces to prevent pulling out. In the two-post standard the sizes of timber are the same, excepting at the foot of the posts, where the construction is made to suit the different conditions encountered.

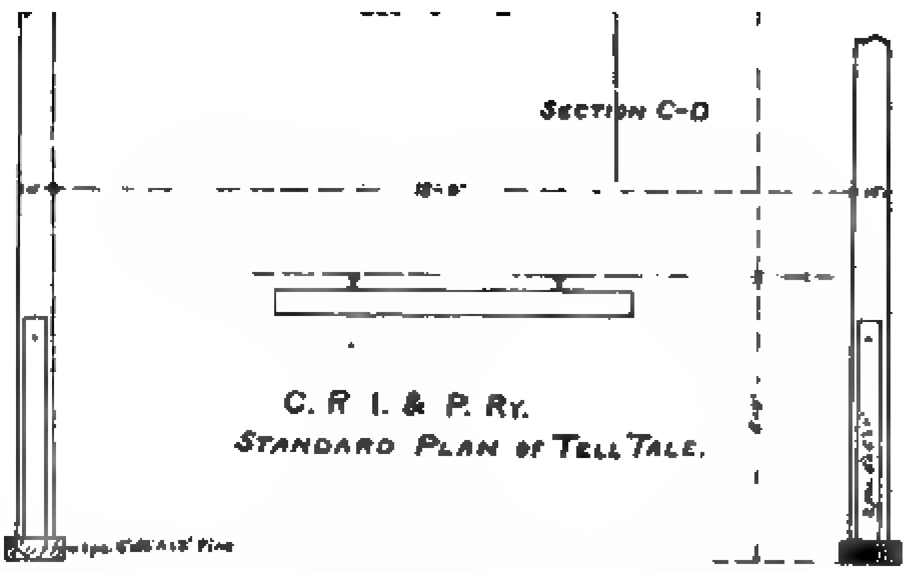
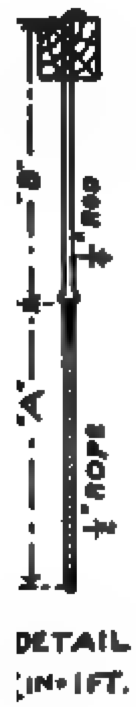


FIG. 16.—Tell-Tale, Chicago, Rock Island & Pacific Railroad. (Plan No. 3, Committee Report on "Bridge Warnings.")

Pennsylvania Company

BRIDGE ALARM.

TO BE USED FOR ALL BRIDGES & STRUCTURES LESS THAN 18'6" CLEAR HEIGHT ABOVE TOP OF RAIL.



SCALE $\frac{3}{16}$ IN. = 1 FT.

TABLE OF DIMENSIONS.

CLEARANCE OF STRUCTURE ABOVE RAIL.									
NOT OVER	15'6"	16'	16'6"	17'	17'6"	18'	18'6"	19'	19'6"
LENGTH OF ROPE "A"	4'1"	3'7"	3'1"	2'7"	2'3"	2'3"	2	2'	2'
" "B" BELOW BAR	3'5"	2'11"	2'8"	2'3"	2'2"	1'11"	1'11"	1'11"	1'11"
" "C" ABOVE RAIL	25'	22'6"	22'3"	22'	21'8"	21'6"	21'6"	21'6"	21'6"

NOTE:

1. THE BOTTOM OF THE ROPES MUST COME AT LEAST AS LOW AS THE LOWEST POINT OF THE BRIDGE TO BE PROTECTED.
2. USE WHITE PINE FOR ALL WOOD.
3. TIMBER BELOW GROUND TO BE TARRED.

FIG. 17.—Bridge Alarm, Pennsylvania Company. (Plan No. 4, Committee Report on "Bridge Warnings.")

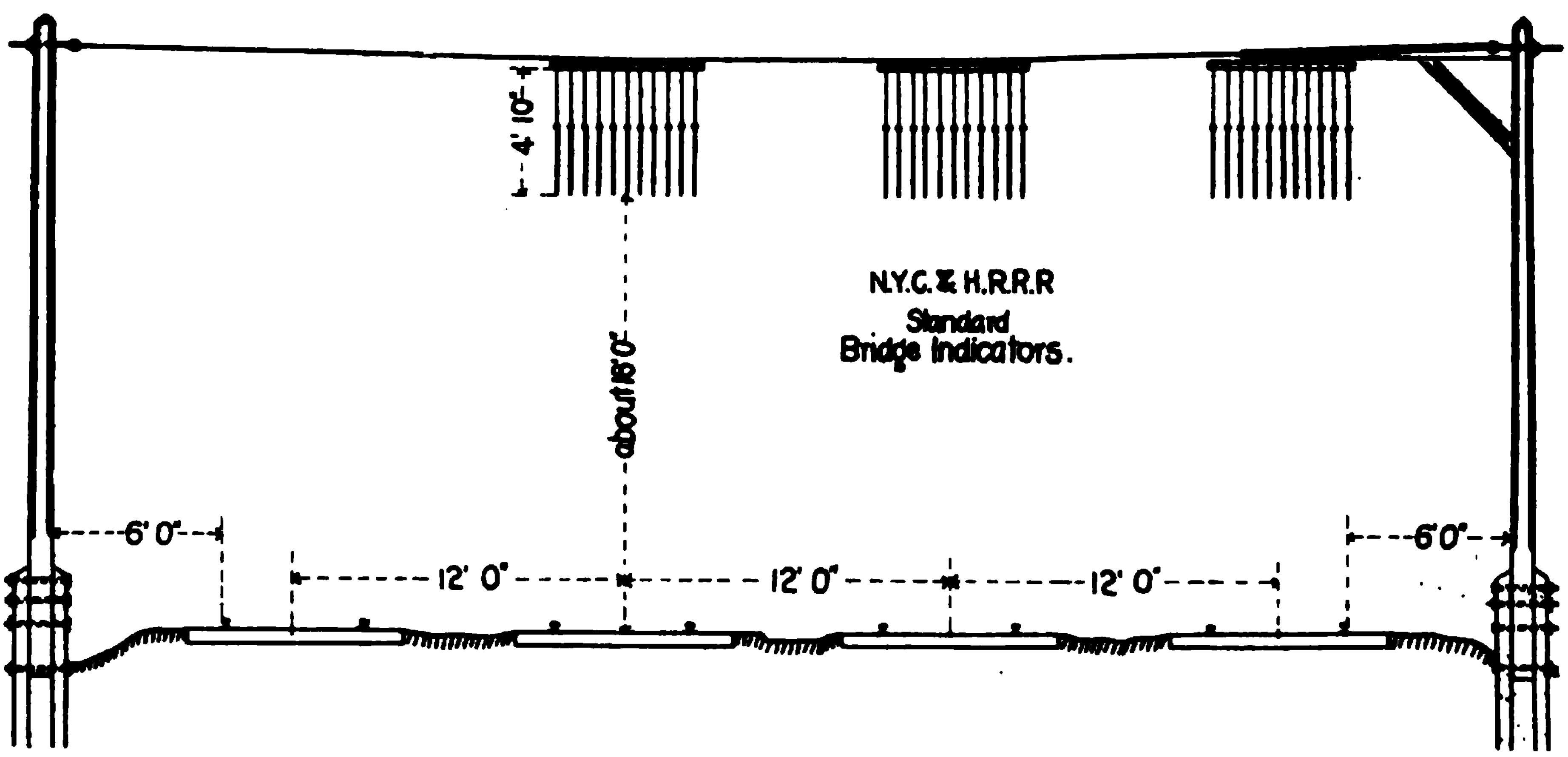


Fig. 18.—Bridge Indicator, New York Central & Hudson River Railroad. (Plan No. 5, Committee Report on "Bridge Warnings.")

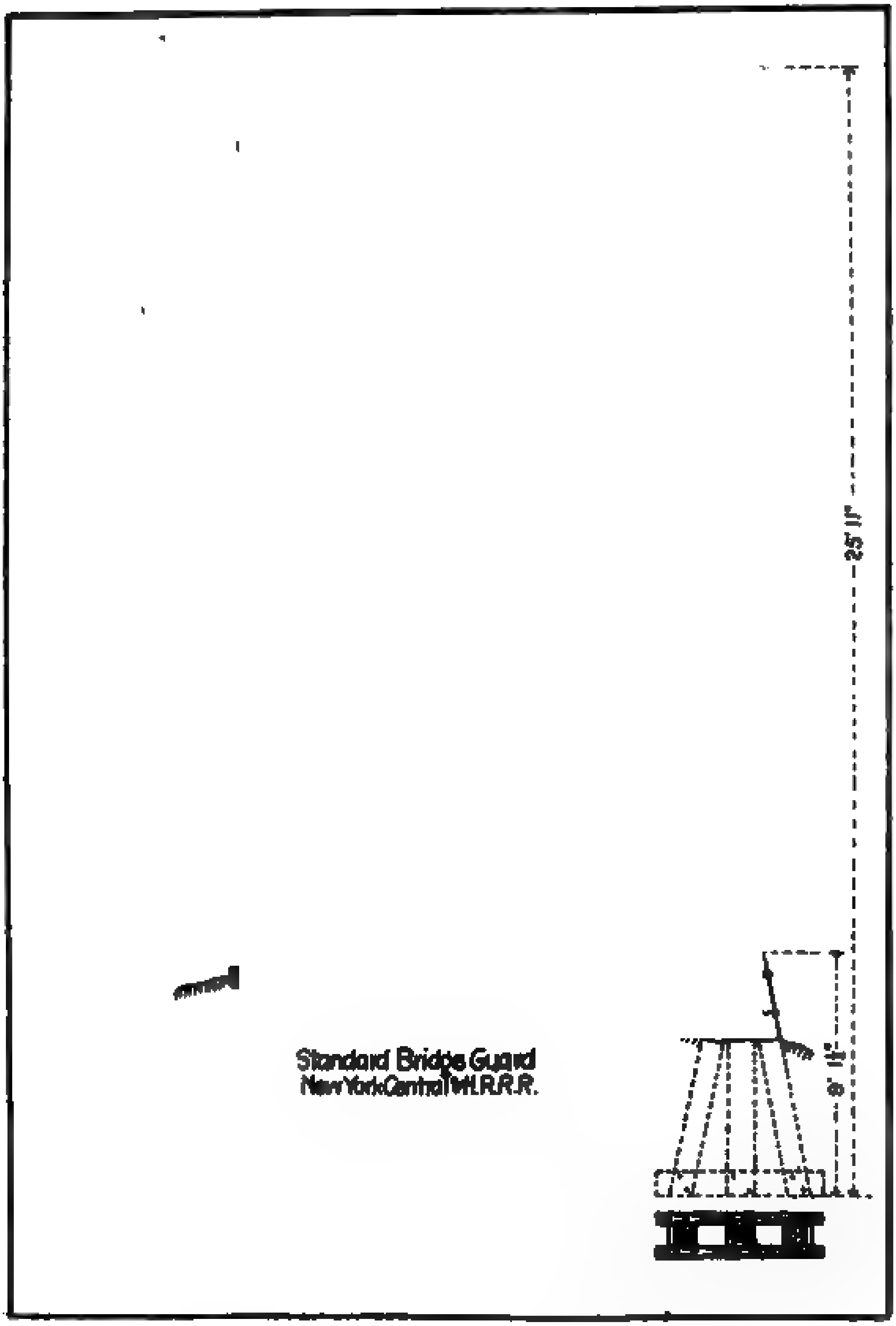


Fig. 19.—Bridge Guard, New York Central & Hudson River Railroad.
(Plan No. 6, Committee Report on "Bridge Warnings.")

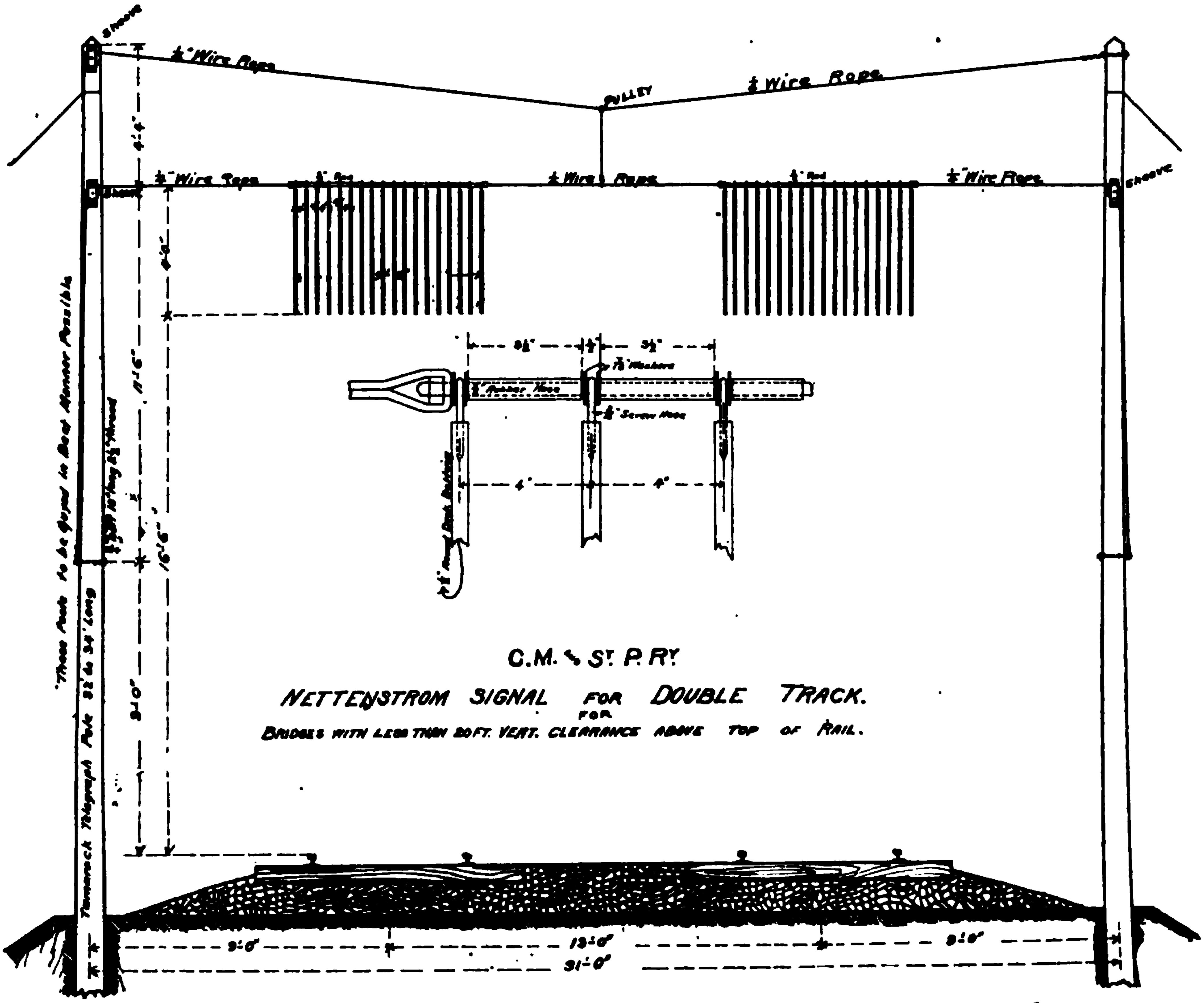


FIG. 20.—Nettenstrom Signal for Double Track, Chicago, Milwaukee & St. Paul Railway. (Plan No. 7, Committee Report on "Bridge Warnings.")

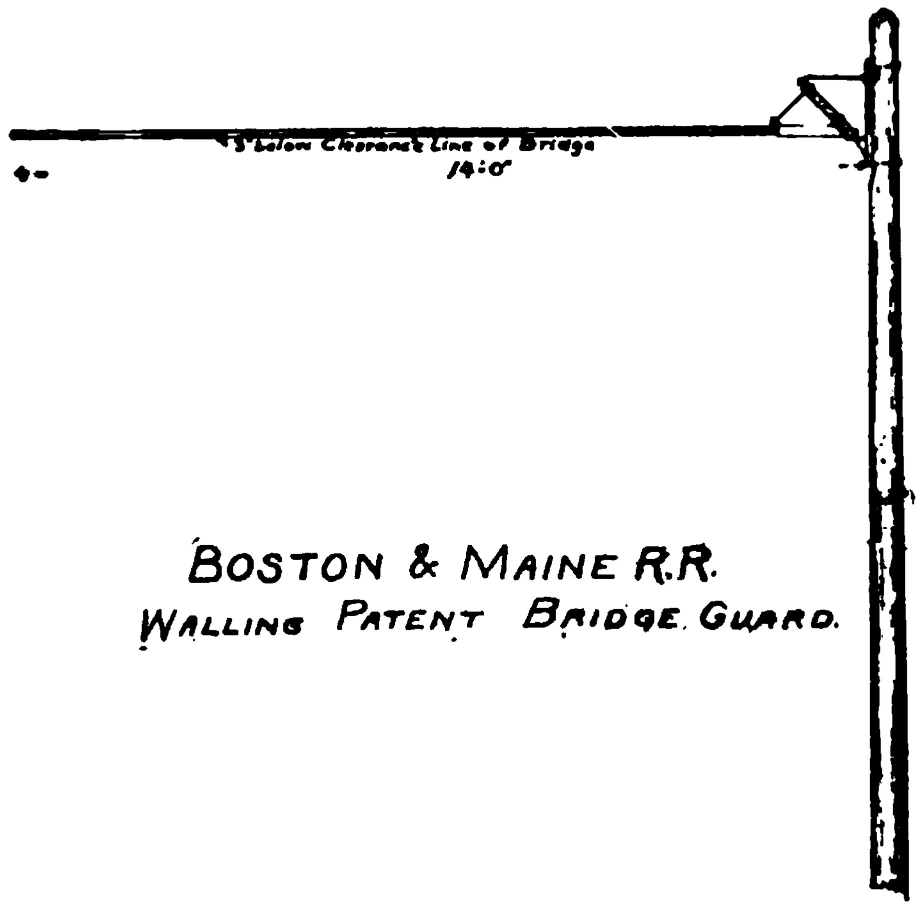


Fig. 21.—Walling Bridge Guard, Boston & Maine Railroad. (Plan No. 8, Committee Report on "Bridge Warnings.")

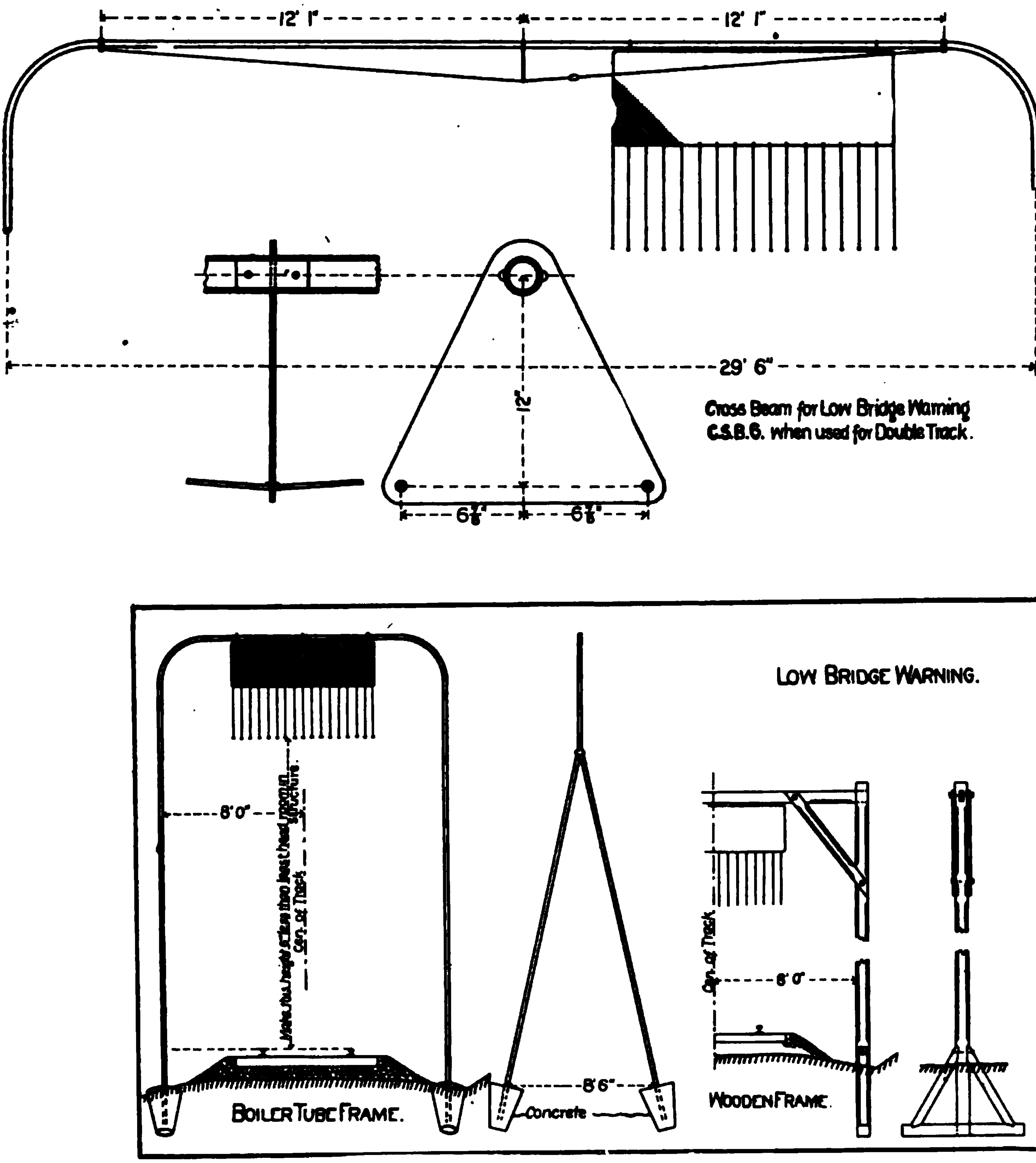


FIG. 22.—Low Bridge Warning, Southern Pacific Railway. (Plan No. 9, Committee Report on "Bridge Warnings.")

DISCUSSION.

Mr. Berg.—I will endeavor to start the discussion by reviewing briefly the principal points covered by the committee report. The committee in its report mentions two special classes of bridge warnings, namely, the vertical rope system and the horizontal swinging-arm system. The relative advantages and disadvantages of these two systems should be discussed.

In the swinging-arm system a light arm or slat is extended horizontally over the track. This arm is hung very delicately in a pivoted or spiral socket to a post alongside of the track, so that when hit it swings out of the way and then returns to its normal position. The principal apparatus with the swinging-arm is generally known as the Walling bridge guard, but there are a number of others of practically the same kind that have no specific name as far as I know.

The tell-tale or vertical rope system, of course, we are all familiar with, as it is more extensively used than any other. In discussing this system, it is more a question of details. The greatest variety of materials in use for the tell-tales, danglers, or ticklers, or whatever they may be called, is well brought out in the report by reference to the Boston & Maine Railroad, where they have actually in use old rope, old bell cords, pieces of rubber, steel tape, wires, and even wooden slats. I think with such a variety of materials and form of construction for the tell-tales proper there should be opportunity for considerable discussion.

The vital point in this tell-tale system apparently is to endeavor to prevent the ropes from being held up out of place, either by the rush of trains, the engine blast, or being tossed or tied up by brakemen. You are familiar with all of these objections. There are a number of methods in use to obtain these features. Some prefer to insert a short piece of wire over the rope proper, making the wire a little longer, or at least as long as the rope, so that the rope will always swing down into place again. Other roads have a wire frame so arranged that when the ropes are struck and fly up they strike the frame and not being able to catch on anything naturally drop down again.

The committee calls attention to a device that our member, Mr. Bishop, reports in use on the C., R. I. & P. Railway; namely, a horizontal, wide piece of board is placed over the tell-tales and is wide enough so that when the ropes are thrown upward they cannot lodge and hang.

Another important question is what materials to use for the main construction, whether of wood, or of iron similar to the design our member, Mr. Isaacs, reports from the Southern Pacific Railway.

Further it is a question whether one or two posts are better. The committee brings out the different features in this connection, and then finally the designs for suspending the tell-tales from a cable stretched over several tracks. The New York Central & Hudson River Railroad design shows a cable kept taut by turnbuckles or screw ends at both posts. Then there is the Nettenstrom signal, as it is called, on the Chicago, Milwaukee & St. Paul Railway. Our member, Mr. Onward Bates, reports this signal as giving very good satisfaction, especially in regard to the ease with which the supporting cable can be let down for repairs. Our member, Mr. Mitchell, reports a cable in use on the Erie railroad, the principal feature of the design being that one end of the cable is brought down to a small windlass in a locked box near the foot of one post; this allows repairs to be made very quickly.

Mr. Cummin.—It seems to me that one of the most important features to be brought out by the members in regard to bridge warnings or bridge signals is the manner of fastening the ends of the double-track cable. Nearly all our single-track ticklers are on the same principle. Those on the single track of the Long Island Railroad are similar to several exhibited in the report, consisting of post and arm with braces under it. On the double-track system, or for two or more tracks, we place posts on each side of the track, and near the top of one post we fasten a cable securely. It runs across to the other post and through a sheave. We formerly fastened a heavy cast-iron weight on that end of the cable to keep the strain on the cable, but found that it was not a success. Now we use a turnbuckle on that end, so that it can be adjusted at any time in making

repairs on a double-track system. It is a small matter to loosen the turnbuckle, fasten a small rope to the cable, and let it run down to the track. We use ¼-inch copper wires, three feet long, with an eye in each end, and on the lower end of the wire we suspend a ½-inch rope four feet long, making the tickler seven feet in length. In the single-track system, if the tickler should get blown up by the exhaust from the engine it would not stay, as there is three feet of the wire to bring it back. We do not use knots on the lower end of the rope; they may answer in summer but are dangerous in winter. I heard of an instance where they advocated the knot system. It worked very well in the summer time, but in the first part of the winter there was a sleet storm and the knots became about the size of a man's fist, and a brakeman lost an eye, and the cost to the railroad company was enough to furnish a good many first-class ticklers. I think the manner of fastening should be discussed.

Mr. Berg.—There is another point I might mention, namely, the location of the bridge warning with relation to the bridge proper.

Mr. Cummin.—In answering that I might say we place them two hundred feet from the bridge, and where there is a number of overhead bridges we place ticklers between the bridges. Some years ago at one town on the road we had four bridges in succession about two hundred feet apart. We had ticklers at the west of the west bridge and east of the east one. A green brakeman was sent out, and after coming to the tickler stooped down and cleared the first bridge but rose up and was struck by the second one, and the jury rendered a verdict against the company, because they did not provide ticklers between the bridges. Since then we have put them up between the bridges.

Mr. Berg.—Mr. Cummin alluded to a point, which I wish to emphasize, and that is the value of studying bridge warning designs and having them properly kept in practice, on account of the liability of a railroad company having to pay damages in case of accident to employés. In going along almost any railroad that I know of, I think we will find lots of bridge

warnings where ropes are tossed and tied up, and frequently out of order, and the day of putting them in order is postponed owing to the difficulty of making these repairs. Therefore, one of the most important features in connection with bridge warnings is the ease of straightening out defective tell-tales, as there is no question but that in case of an accident testimony would be offered as to the condition and all circumstances connected with the bridge warning in question.

Mr. Cummin.—I explained the manner of letting down the cable on our double-track warnings. On single track we have a post and arm, and we do the repairs by using a light sectional ladder. A man puts the ladder together and goes up to do the repairs.

Mr. Staten.—We fixed up a single post 10x12 with a good sill and four kneebraces planted in the ground very substantially, with a cross-arm and kneebrace at top. For the signal we bought some good leather made into strips about four feet long, as we thought they would keep clear of snow, and the engine exhaust would not knock them up; but it was only a little while before all the brakemen had good razor-strops and we had no warnings.

Mr. Patterson.—I think the tendency is to put them too far from the bridges, and that gives the brakemen an opportunity to get up between the tell-tales and the bridge and be hit by the bridge. The law for New Hampshire is 150 feet. I think that is a little too far, 100 feet would be better.

Mr. Hanks.—Our tell-tales are inlaid with No. 6 wire, ends tucked so as not to cause any injury to a brakeman. The ropes are $\frac{5}{8}$ inches three-ply with space of six inches, eighteen inches from lower end not inlaid. This allows them to double up when brakeman comes in contact with them. The tangling below and laying over the cross-bar has been stopped with the use of the wire screen above and the inlaid wire.

Mr. A. J. Kelley.—Our system of tell-tales is similar to that described by Mr. Cummin of the Long Island Railroad, and has proved about as unsuccessful on our line of road as on his. It requires a great deal of attention and labor to keep the tales or ticklers in proper position so that they will notify trainmen

of approaching danger. However, the disarranging of the thongs or tales, whether of cords or leather, is done mostly by trainmen cutting them or knocking them off the wire cable with brake clubs. The very men whom they were erected to protect are their enemies.

Mr. Staten.—We have a bulletin of rules and every man who hires as a brakeman has to study it thoroughly, so as to know where the warnings are before he becomes a brakeman.

Mr. Cummin.—I think all the members of the association will agree with me on one thing, and that is that the main difficulty is caused by the very men for whose protection warnings are provided. If a freight train is stopped under the tickler, a brakeman, as a rule, will not allow the opportunity to go by without doing something to injure the tickler.

Mr. Pullen.—We have on the Ohio Division of the B. & O. S. W. quite a number of danger signals, or ticklers, and find we have to repair frequently where they are used close to stops or water stations. When trains slow up we believe brakemen pull or throw up the ropes.

Mr. Shane.—My idea is that these bridge warnings are not put up for the purpose of protecting brakemen alone, but to protect the railroad company as well.

Mr. Eilers.—In regard to bridge warnings we have them for viaducts and for double or single track on our line. For a single track they use cross arm on top with double wires two feet long and bell cord for the tell-tale. For the double track we use wire across the top and we also use it for the Burlington viaduct and Burlington hill, placing a washer on each side of loop in the wire that comes down, so that if the exhaust of the train going up the hill strikes this wire it goes right over and comes back and does not get tangled up. I think this is the best thing I have seen yet and we have had no trouble at all. It keeps straight and does not get tangled up or tied up.

Mr. Cummin.—In reply to Mr. Shane's remark that the bridge warnings are not for the purpose of protecting brakemen but for the protection of the railroad company, the laws of the state of New York compel railroad companies to erect them for the purpose of protecting the trainmen.

Mr. Sheldon.—We have tried various kinds, using old rails for posts and with the cross arm. We have used the perpendicular pendant and swinging arm, but discarded the swinging arm. We now use the perpendicular pendant with cross arm, and it has to be put up in accordance with the orders of the railroad commissioners, at least twenty-two feet above the track, and the pendant shall dangle at least three inches below the obstruction.

On three or more tracks we use the cable. For five or more tracks we use the double cable with suspension cable across the top, the bottom one being drawn tight in the same manner as is shown on plan No. 7 of the committee report. The top half of the pendant is a No. 5 wire with a loop in each end and screwed to the cross arm on top with a screw eye. The lower half of the pendant is of rope and we seize the bottom end of that and dip it in molten tar or wax of such a consistency as to be pliable but not soft, and not hard enough to crack. We have the best satisfaction from this plan. From the other designs of posts and pipes across the track we do not get good results.

Mr. Berg.—If any member has used or known of the use of the swinging arm system, I will be glad to hear with what success. I refer to the swinging arm or slat projecting out from the track.

Mr. Patterson.—We use the cross arms, but personally I do not like them, although the railroad commissioners accept them as a form of bridge warning. Therefore, we use them because we have them on hand, but the trainmen break them very frequently and it is very hard to locate who does it, and it requires constant watching to keep them in order. Personally, I am in favor of the pendant system.

Mr. Berg.—I would state that on the Lehigh Valley railroad the horizontal slat system was introduced eight or ten years ago. It was not, however, distinctly the Walling bridge guard. There was some improvement on it, although, I believe, the patentee claimed it was an infringement on his patent. Mr. Harwig, who is chairman of the committee and connected with the Lehigh Valley Railway, has stated that the horizontal slat

system did not give satisfaction because in high winds it is liable to be blown out of position, and further in winter the spiral joint connection is likely to get clogged up with water, and freeze. Mr. J. P. Snow of the Boston & Maine Railroad, in speaking of the horizontal slat system, says that the Walling bar is not so likely to get out of order as another system with counter-weighted slats that they have, and that the Walling bar is effective except in case of very high wind. I think these exceptions tell against the horizontal swinging slat system, and I think the committee was perfectly correct in coming to the conclusion that the vertical rope, or pendant, system is after all the only system that should preferably be used.

Mr. Mallard.—Some of the members have talked about the brakemen cutting the straps or ropes. They are the men for whom they are put up and if we find a man who destroys them, we discharge him. If we caught any of our men with a telltale razor-strop we would give him a time check and we would put on a watchman if they continued to interfere with them.

Mr. Berg.—The question is to catch them. There is the same trouble at stub-end sidings where there are bumpers. If the end car is damaged in the morning or the bumper damaged it is almost impossible to decide which shifting crew during the night did the damage.

VIII. Stock-yards and Stock-sheds, including all Details of Construction.

REPORT OF COMMITTEE.

To the President and the Members of the Association of Railway Superintendents of Bridges and Buildings:

Your committee appointed at the sixth annual convention held in Chicago, Oct. 20, 1896, to report on the subject, No. 10, viz: "Stock Yards and Stock Sheds, including all details of Construction," at the seventh annual convention, after making a thorough investigation, submit the following report:

One of the largest and most important industries of the West is the stock business. When the stock is ready for the market it is necessary for the railroad companies to have good facilities for the prompt handling of the shipments. In building stock yards the style, to a large extent, is governed by the location and right of way owned by the railway companies. Stock yards should be located on high ground, slightly sloping, so pens can be drained. If high ground is not available, the location selected should be graded up for that purpose. The size of stock yards depends on the amount of stock in the vicinity for shipment, and the number of shippers.

Railway companies should have standard plans of stock yards, with details of construction for one or more pens, so that in case additional pens are required, they can be added at any time, without making any alterations in the pens already built.

[Note.—There may be a few instances where you cannot always adopt the standard stock-yard plan; as a general thing it can be done.]

On account of the sharp competition for stock shipments between the railway companies, the shippers are sometimes allowed permission to use the stock yards for a week or more, until they can secure enough for shipment, or for a better market. This practice is expensive to railway companies, as they are compelled in some cases to erect stock sheds for the protection of stock from storms and heat.

In cases of this kind railway companies, in order to keep the yards in proper condition on account of the cattle and hogs being held in the yards, are compelled to fill the holes in the yard with dirt, gravel, or broken stone, and in some instances, plank or pave one or more pens so as to make the yard passable.

At some stations stock yards are not considered complete without loading and unloading chutes, with gang-plank or double-deck chute for loading double-deck cars, and also stock scales for weighing.

All stock yards should have water and water-troughs in one or more pens, especially where hogs are handled; also a portable hog chute for unloading hogs from wagons.

Plans No. 1 and 2.

Chicago, Milwaukee & St. Paul Railway Company's standard plans for stock yard and shed.

No. 1 shows plan of yard, chute, fence, platform, and water-trough; also cross-section of shed and feed-rack.

No. 2 shows plan of details of yard, staple, gate-hook, gate-bar, gate-hanger, chute-gates with extension slide, rear alley gates, and sectional view of fence.

Plans No. 3, 4, and 5.

Toledo, Peoria & Western Railway Company's standard plan for stock yards and stock shed.

No. 3 shows plan of details of stock-shed, showing cross-section and elevation plan, stock yard gate, stock yard gate hinges, gate lugs and gate stops. Cost of stock shed 90 cents per lineal foot.

No. 4 shows plan of four-pen stock yard, showing section of fence and chute used at large shipping stations. Cost of labor $100, material $100, total $200.

No. 5 shows plan of two-pen stock yard, 36x72 feet, with chute and platform. Used at small stations. Cost of labor $56, material $52, total $108.

Plans No. 6, 7, 8, 9, and 10.

Standard plans of stock yards of St. Joseph & Grand Island Railway Co.

No. 6 shows details of stock-yard hardware.

No. 7 shows large gates and fence, small gates, panel of portable fence, in connection with portable chute and hay-rack.

No. 8 shows portable chute, chute with swing gate and platform.

No. 9 shows No. 1 yard, one pen 75x64 feet, with alley and chute; No. 2 yard, 75x148, with two pens and alley, chute and platform, also chute with sliding gates.

No. 10 shows No. 3 stock yard, 200x225 feet; nine pens, two alleys, two chutes, with platform and stock scale.

Plans No. 11, 12, 13, 14, 15, 16, 17, 18, 19, and 20.

Chicago, Rock Island & Pacific Railway Company's standard stock-yard and stock-shed plans.

No. 11, plan of stock shed, showing rear view, end view, front view, and cross-section, with feed-rack, and bill of material for 16 feet shed.

No. 12 shows four-pen yard, 104 ft. x 104 ft., with alley, chute, and loading platform, with stock shed located to face south. This style of yard is used east of Missouri river at large shipping stations.

Plan No. 13 shows stock shed to be used at very large feeding stations, 40x48 feet, 11 feet high, with four-ply gravel roof; showing ground plan, half side elevation, half longitudinal section, half end view and half cross-section, with hay-rack, feed-box, and water-troughs.

No. 14 shows details of front elevation of platform and chute, bridge, 4-feet chute gate, adjustable gate and platform, and side elevation of chute.

No. 15 shows details of yard, fence, and gate, 10-feet gate, gate-hinges, gate-stop, gate-hook, and eye-bolts.

No. 16 shows standard plan of yard No. 1, one pen 47x51½ feet, with alley, chute, and platform. Cost of labor $39.25, material $90.75, total $130.

Yard No. 2, 47½x107 feet, shows two pens, with alley, chute, and platform. Cost of labor $49.75, material $115.25, total cost $165.

No. 17 shows plan of yard No. 3, 105x111 feet, three pens, with two alleys, chute, and platform. Cost of labor $64, material $140, total cost $204.

No. 18 shows No. 4 yard, 105x166½ feet, five pens, two loading chutes, one single and one double deck, two alleys and platform, with stock scale located for weighing both stock and grain.

No. 19 shows yard No. 5, 105x166½ feet, seven pens, one double-deck

and one single-deck chute, and one unloading chute, two alleys, one scale located for weighing both stock and grain.

No. 20 shows plan of a branding chute.

[NOTE.—The Chicago, Rock Island & Pacific Railway Company use the standard plans of yard 1, 2, 3, 4, and 5, west of Missouri river, wherever the company has right of way enough to build the yards. Otherwise, yards are built to suit the grounds that are available.]

PLAN NO. 21.

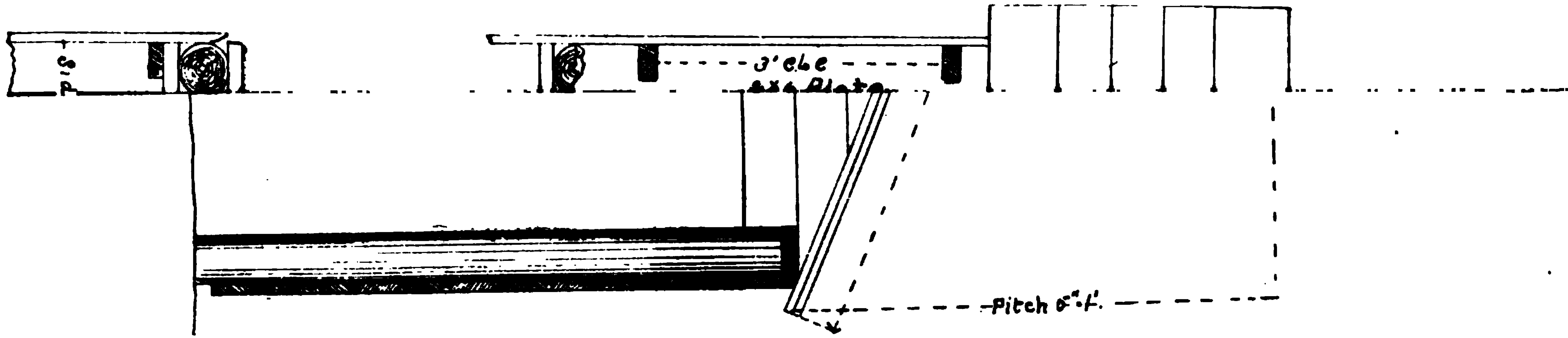
Standard plan of stock yards of Wabash Railway, 72x101 feet, four pens, showing detail of section through chute, front elevation of chute, also alley and chute with platform. Cost of labor $65, material $81, total $146.

PLAN NO. 22.

Standard plan of Pennsylvania Company's Northwestern System, showing detail of stock shed, side elevation, end elevation, and gate for stock pens; size of shed 26½x48 feet. Cost of labor $20.70, material $33.11, total $53.81. No charge for supports, as sheds are built on yard posts.

Respectfully submitted:

GEO. J. BISHOP,
W. R. CANNON,
O. H. ANDREWS,
JAMES BRADY,
Committee.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S.I.D.

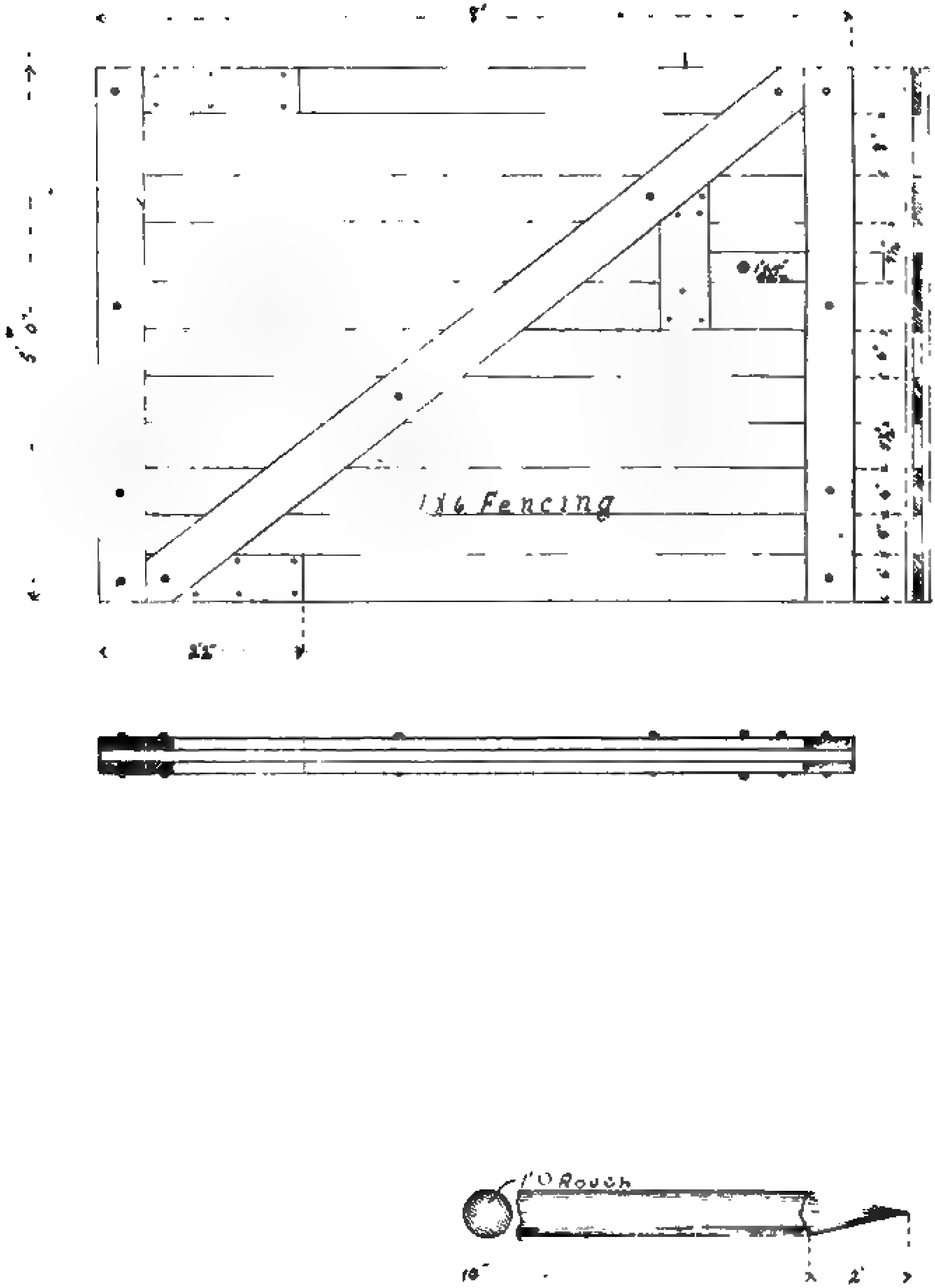


Fig. 26.—Stock Yard Gate and Prop, Toledo, Peoria & Western Railway. (Plan No. 3, Committee Report on "Stock Yards and Stock Sheds.")

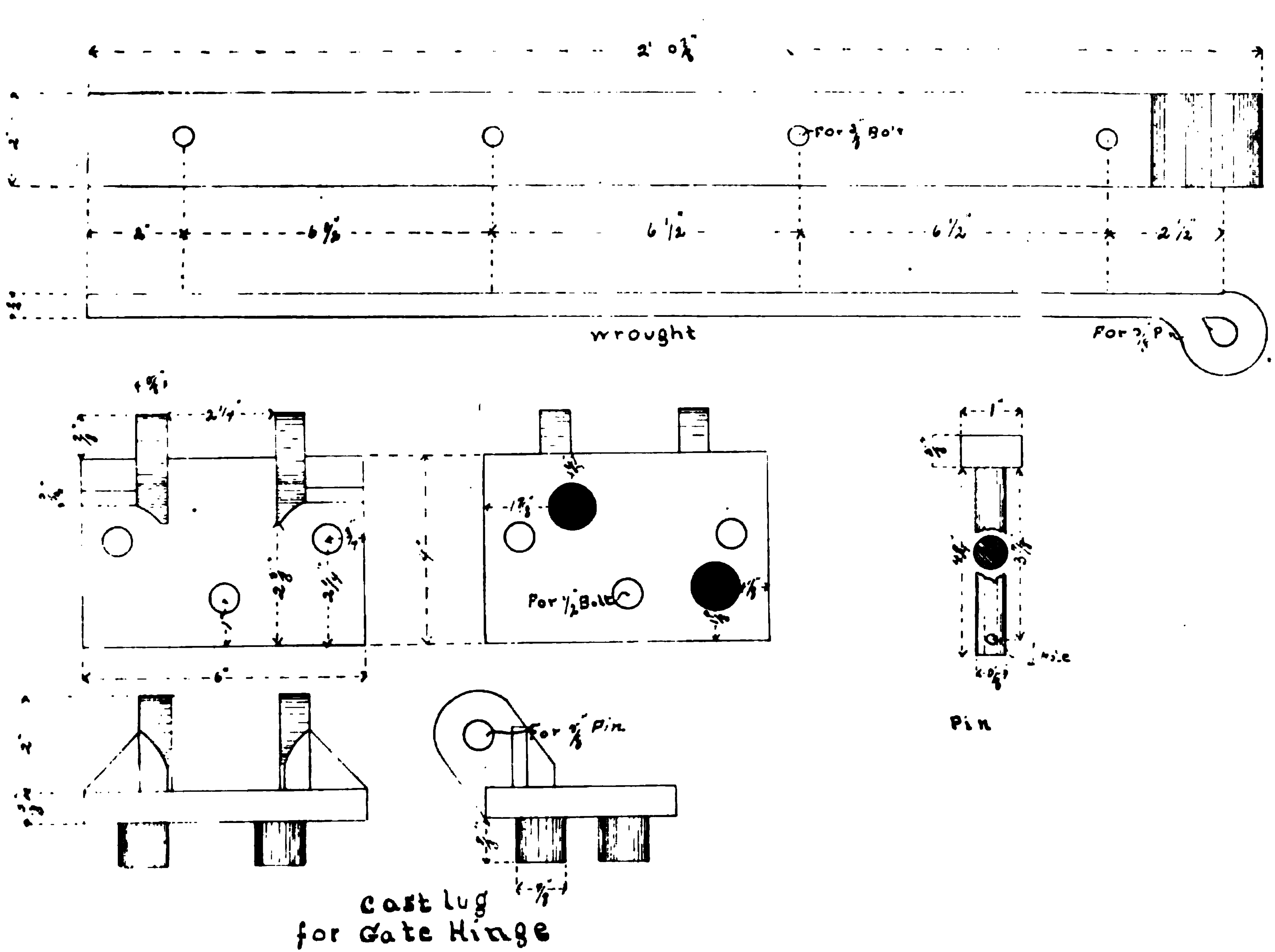


FIG. 27.—Details of Irons for Stock Yard Gate, Toledo, Peoria & Western Railway. (Plan No. 8, Committee Report on "Stock Yards and Stock Sheds.")

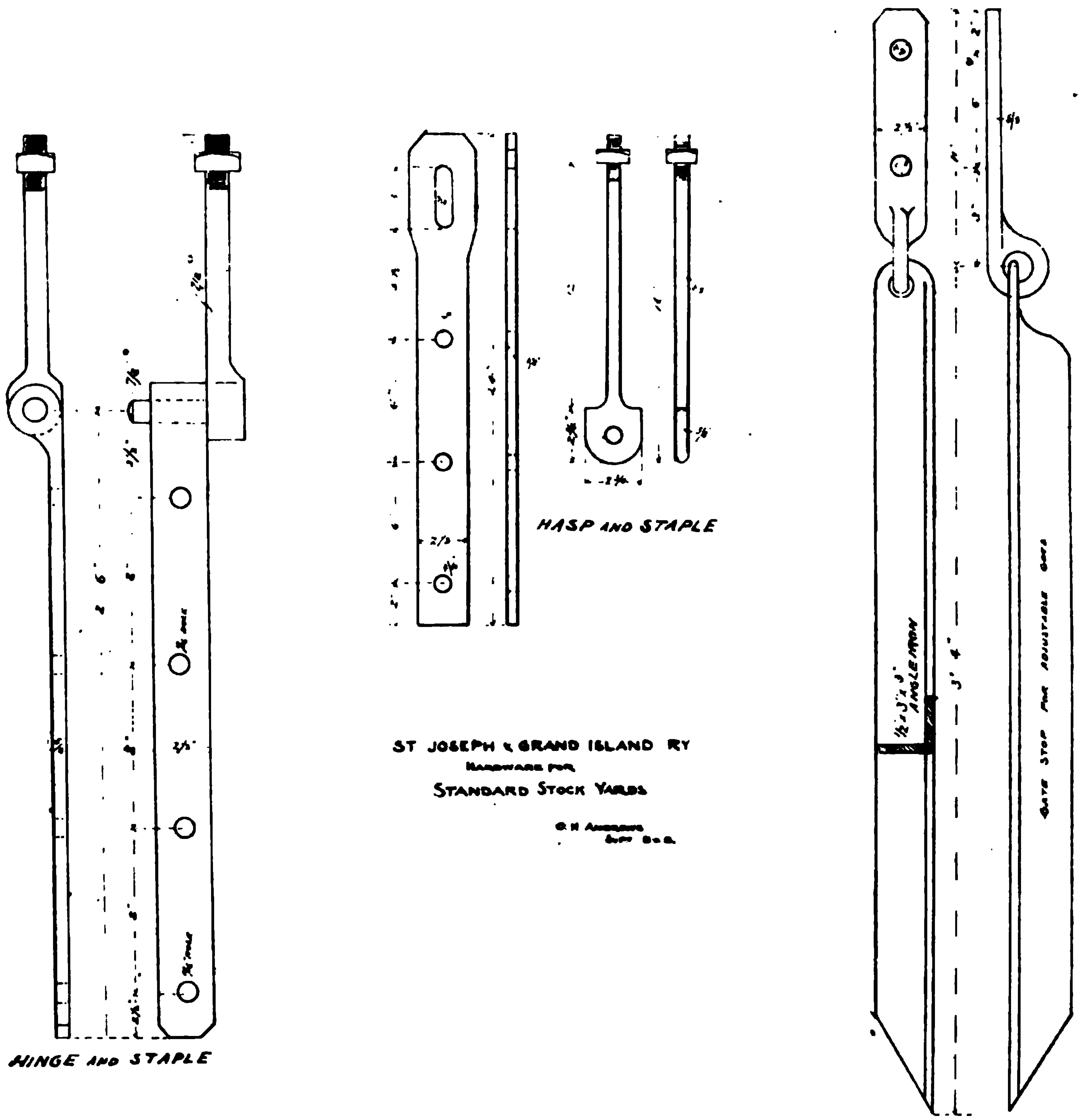


Fig. 80.—Stock Yard, Details of Hardware, St. Joseph & Grand Island Railway. (Plan No. 6, Committee Report on "Stock Yards and Stock Sheds.")

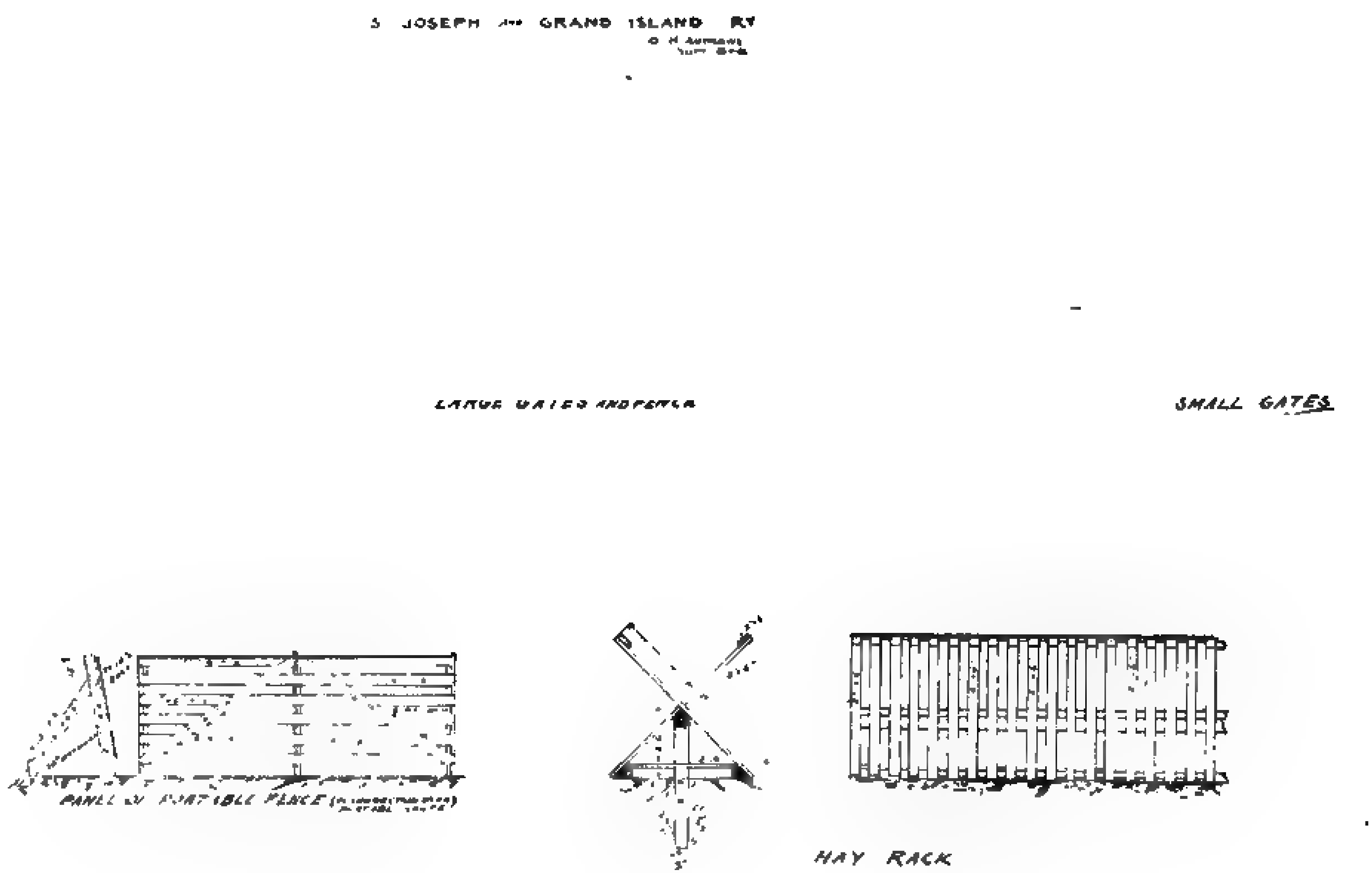


FIG. 31.—Stock Yard Details, St. Joseph & Grand Island Railway. (Plan No. 7, Committee Report on "Stock Yards and Stock Sheds.")

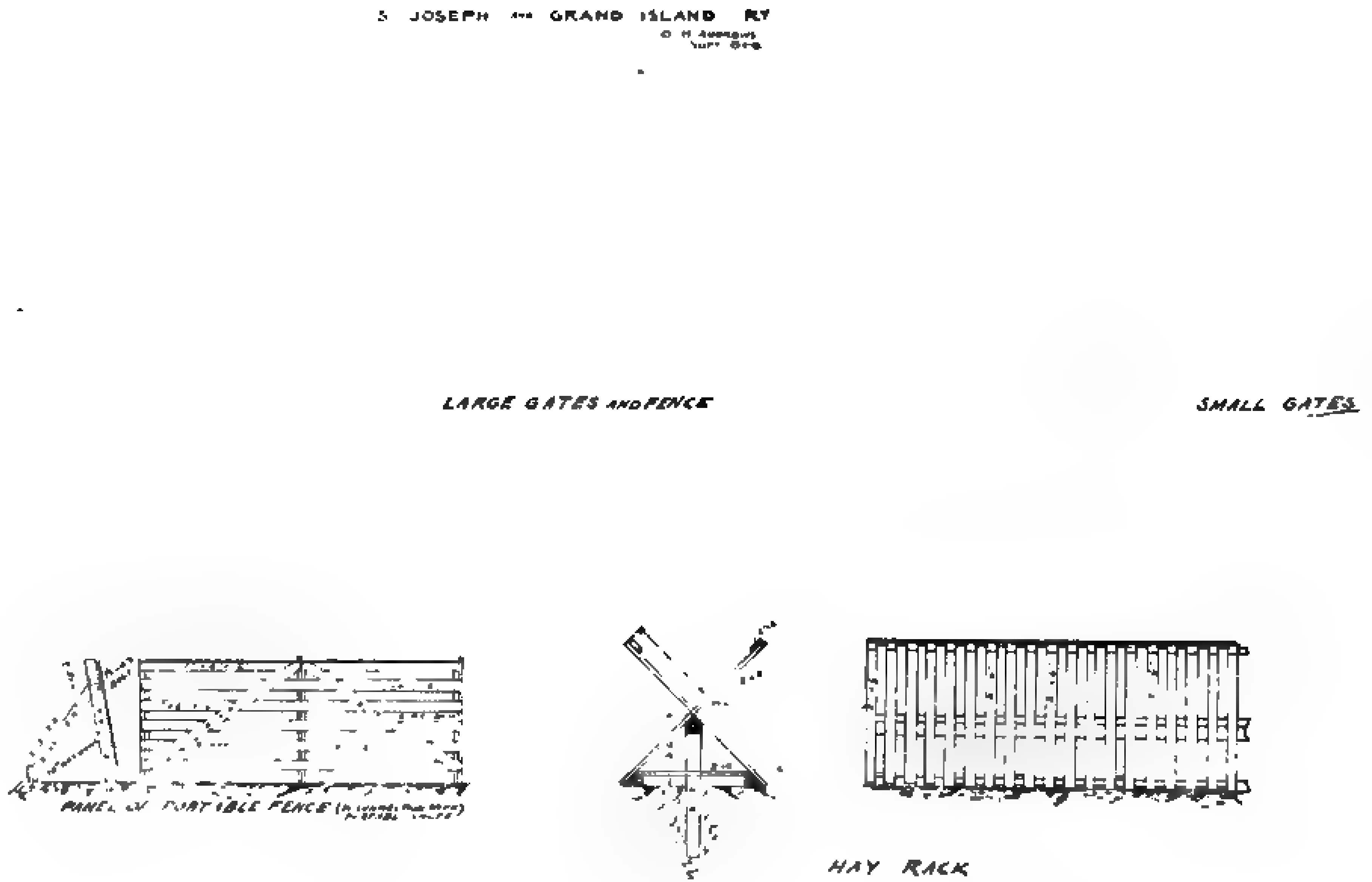


FIG. 81.—Stock Yard Details, St. Joseph & Grand Island Railway. (Plan No. 7, Committee Report on "Stock Yards and Stock Sheds.")

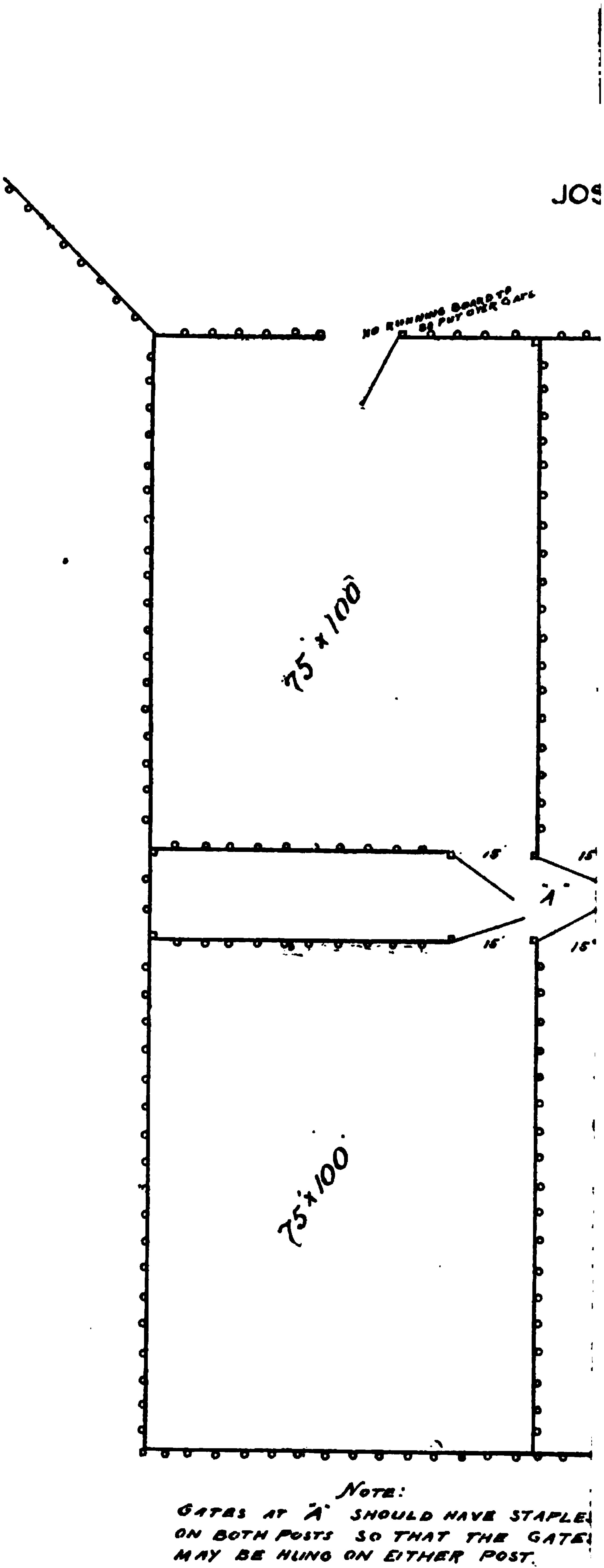


FIG. 34.—Stock Yard No. 3, St. Joseph & Grand Isla

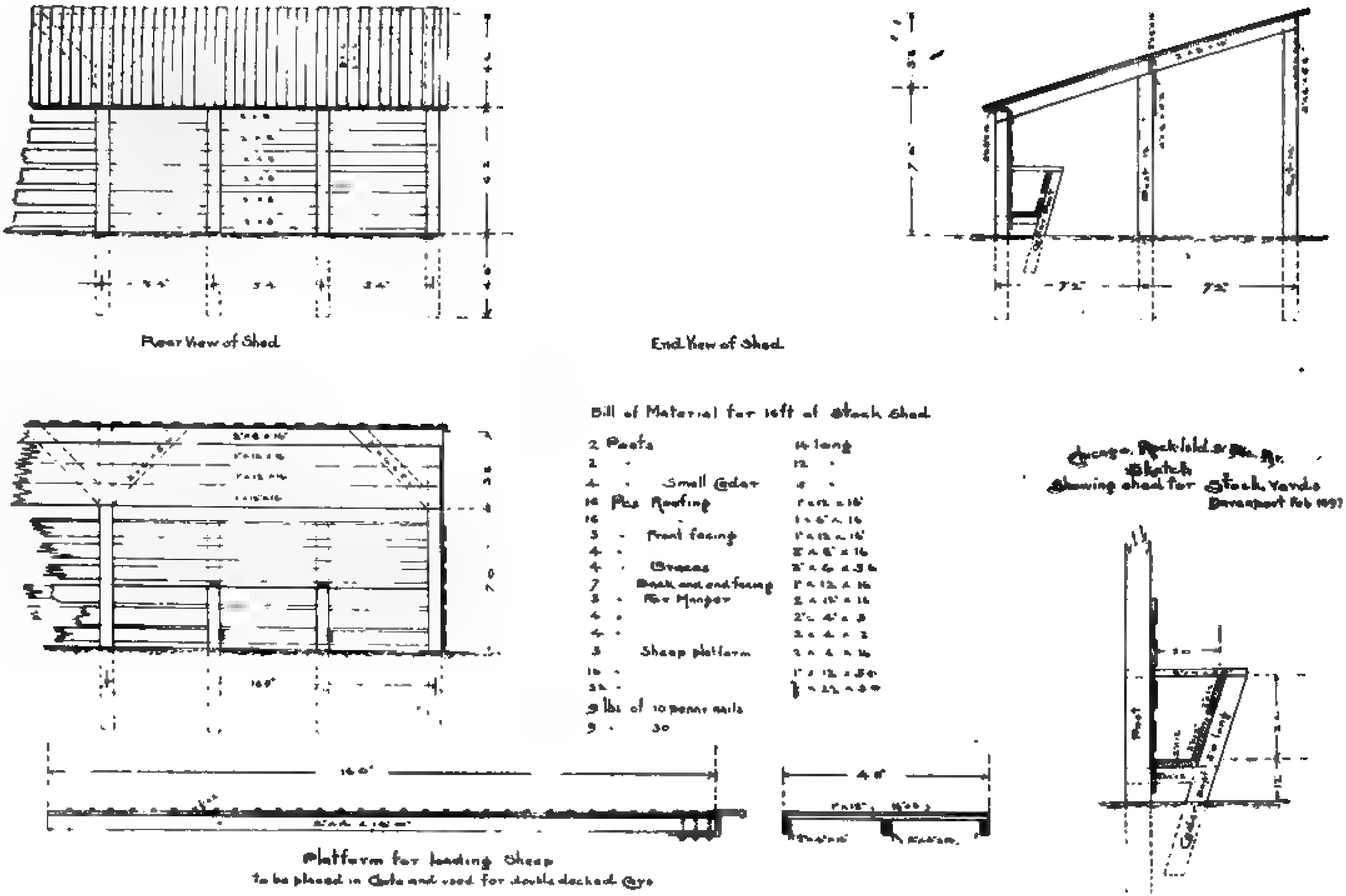


Fig. 85.—Stock Shed, Chicago, Rock Island & Pacific Railway. (Plan No. 11, Committee Report on "Stock Yards and Stock Sheds.")

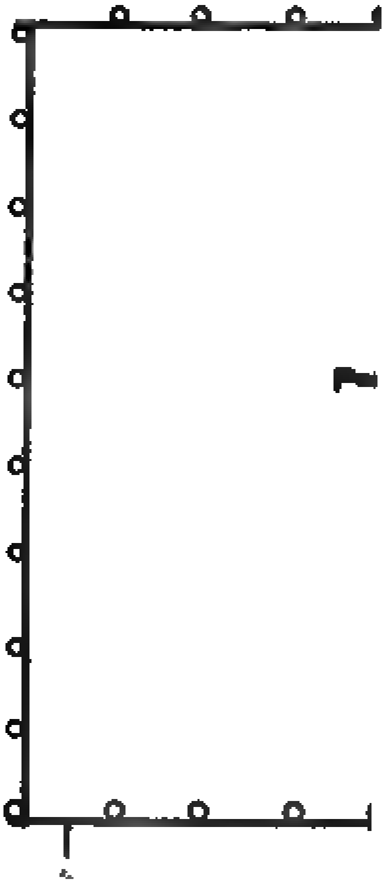


FIG. [illegible].—Four-Pen Stock Y

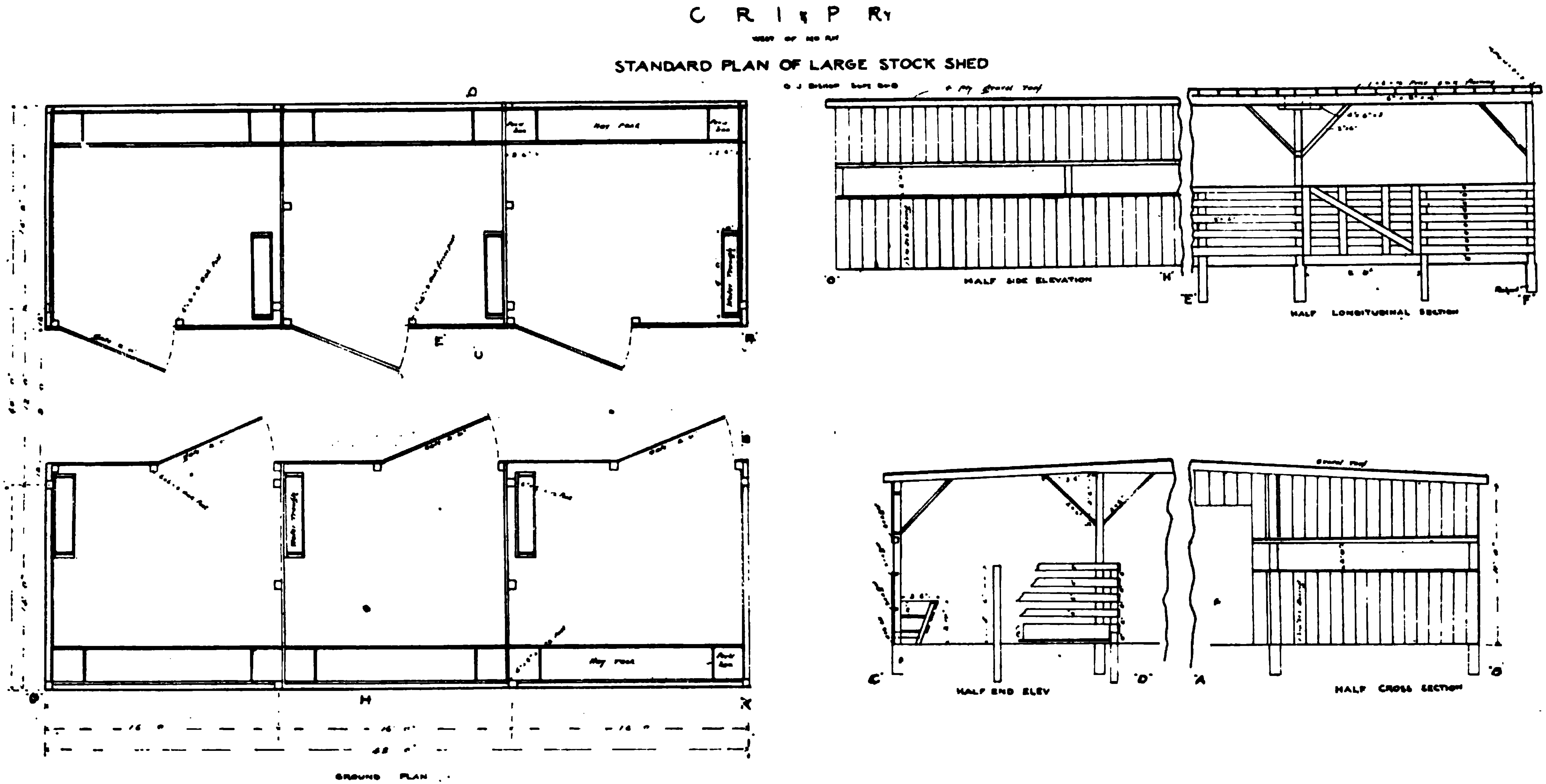
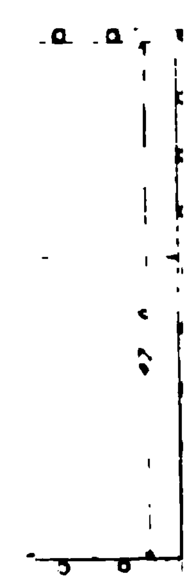
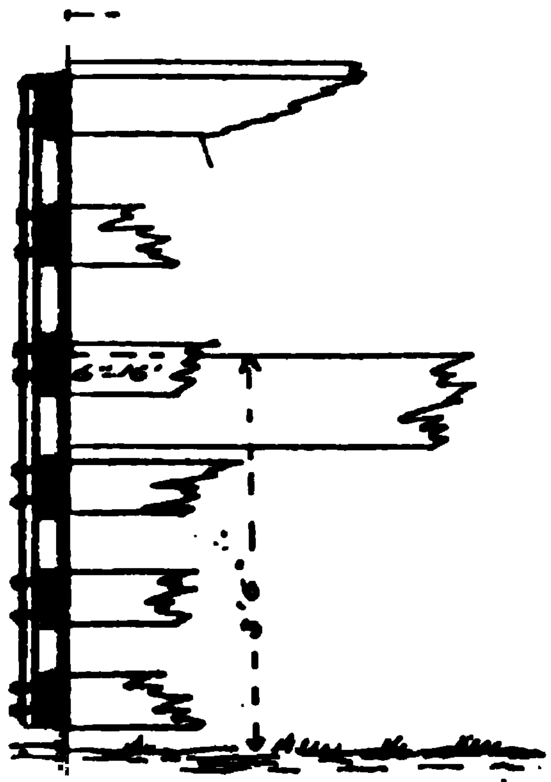
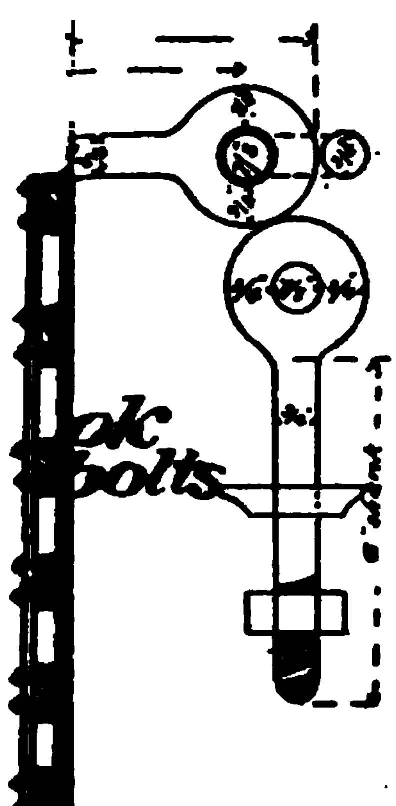
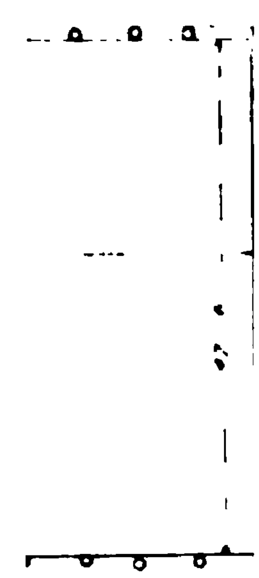


Fig. 37.—Large Stock Shed, Chicago, Rock Island & Pacific Railway. (Plan No. 13, Committee Report on "Stock Yards and Stock Sheds.")









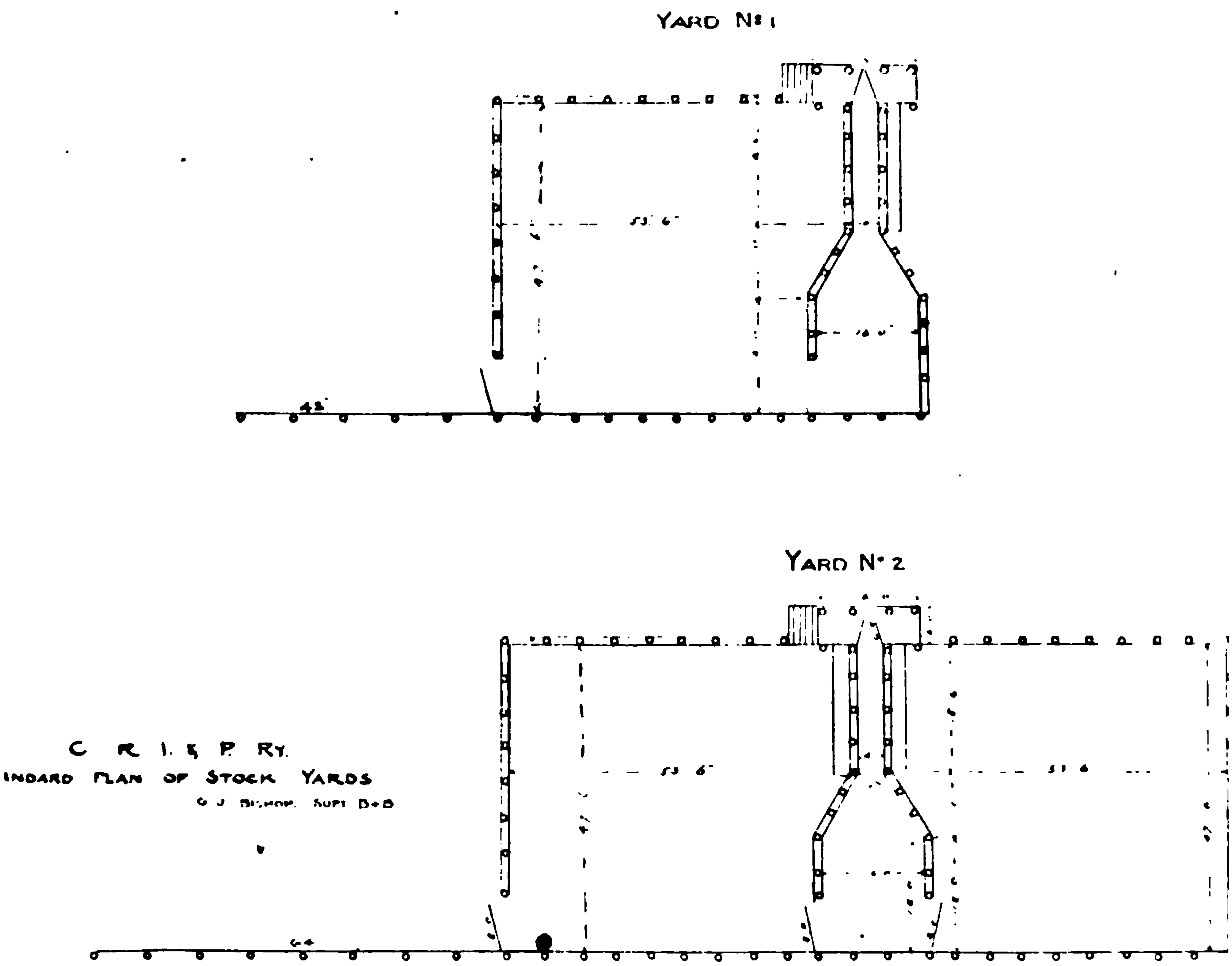


Fig. 40.—Stock Yard No. 1 and No. 2, Chicago, Rock Island & Pacific Railway. (Plan No. 16, Committee Report on "Stock Yards and Stock Sheds.")

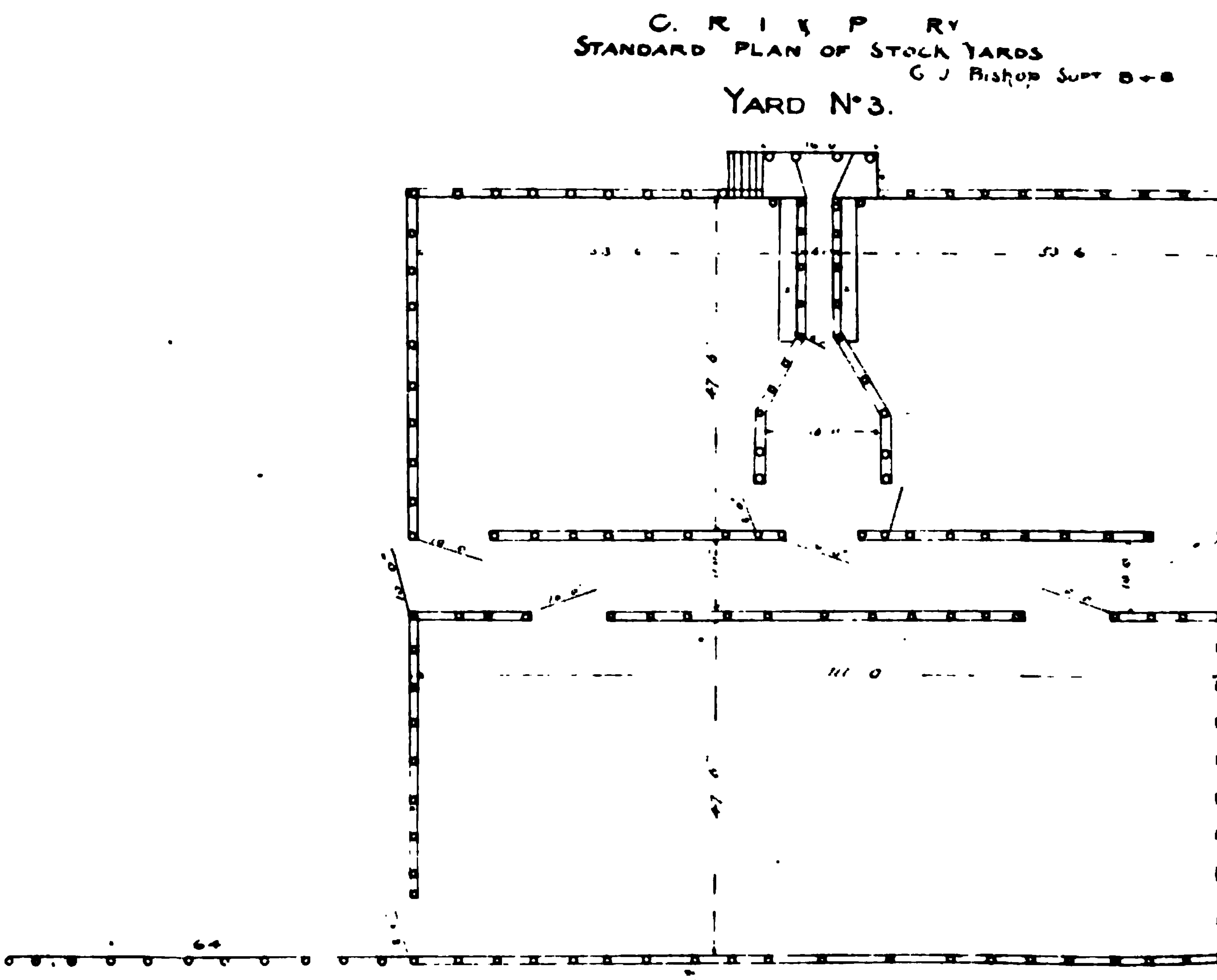


FIG. 41.—Stock Yard No. 3, Chicago, Rock Island & Pacific Railway. (Plan No. 17, Committee Report on "Stock Yards and Stock Sheds.")

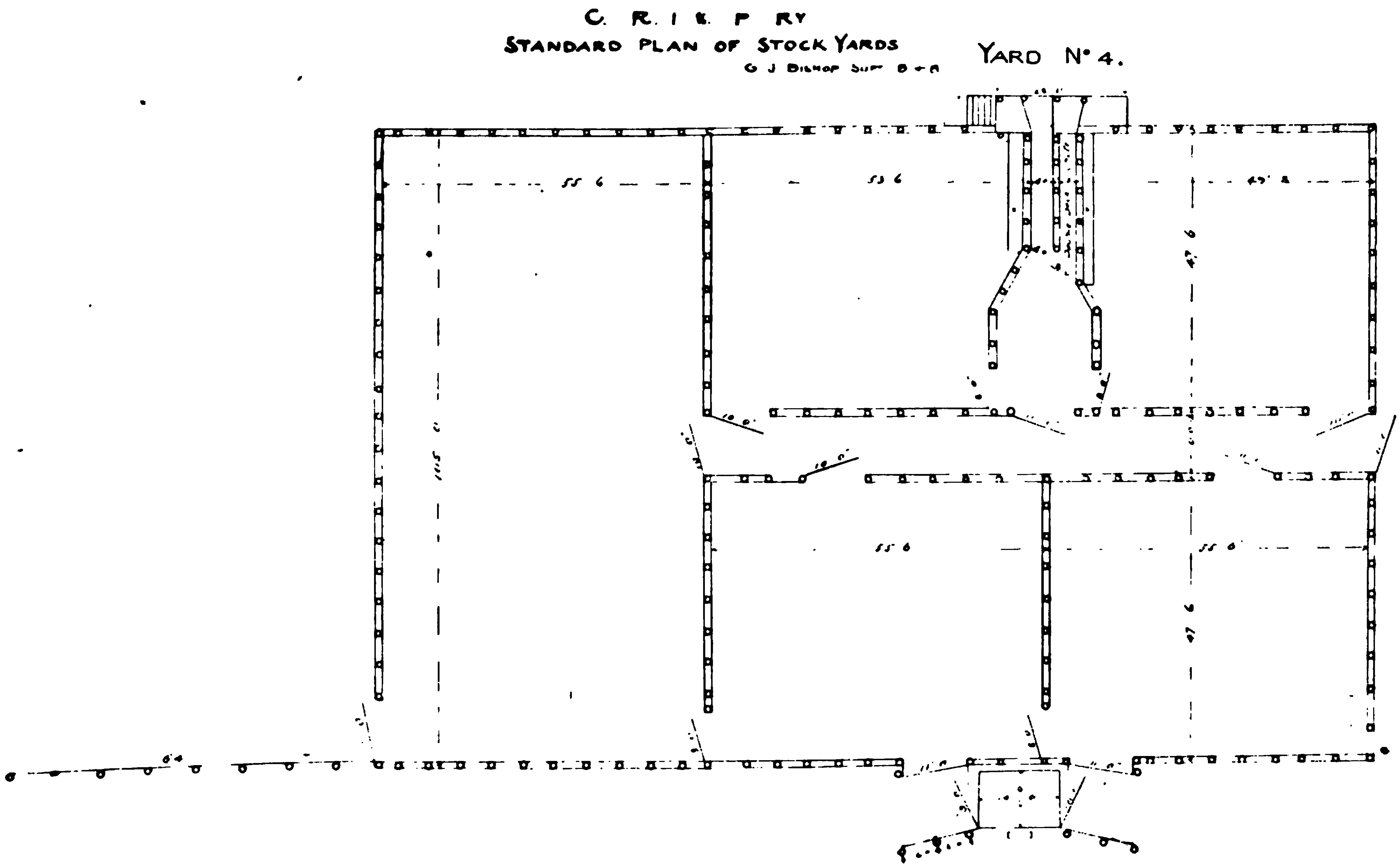


FIG. 42.—Stock Yard No. 4, Chicago, Rock Island & Pacific Railway. (Plan No. 18, Committee Report on "Stock Yards and Stock Sheds.")

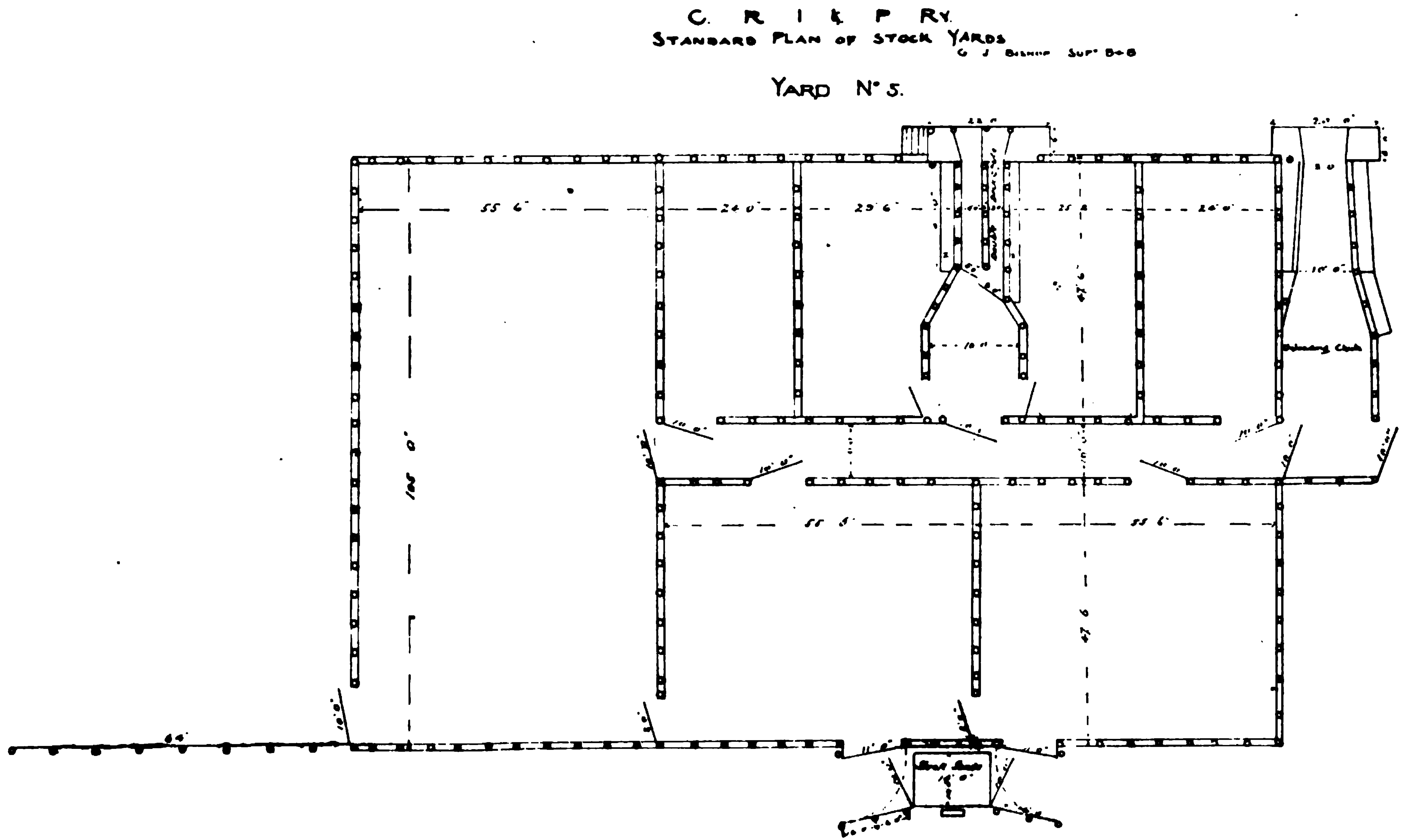


FIG. 43.—Stock Yard No. 5, Chicago, Rock Island & Pacific Railway. (Plan No. 19, Committee Report on "Stock Yards and Stock Sheds.")

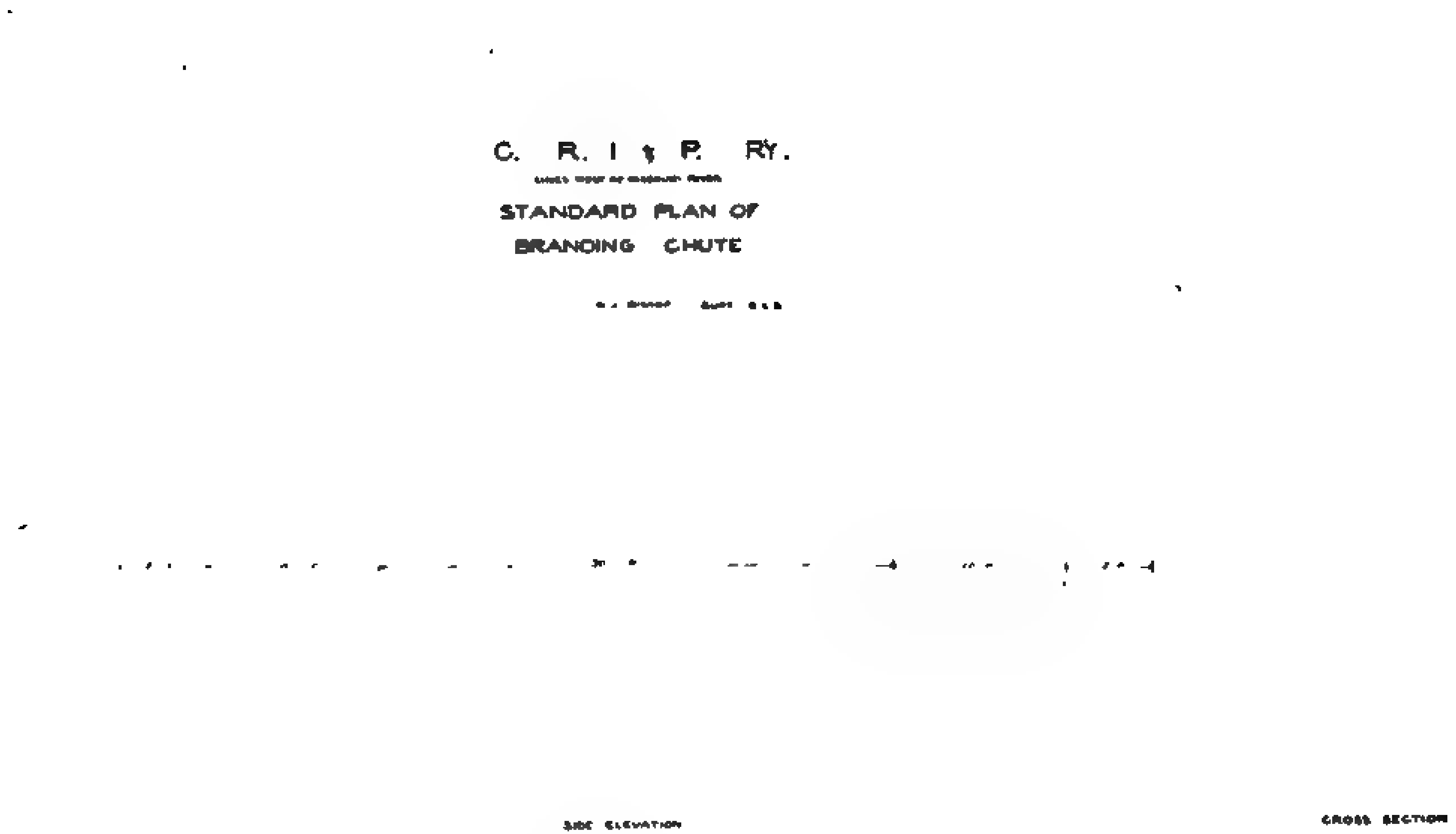


FIG. 44.—Branding Chute, Chicago, Rock Island & Pacific Railway. (Plan No. 20, Committee Report on "Stock Yards and Stock Sheds.")

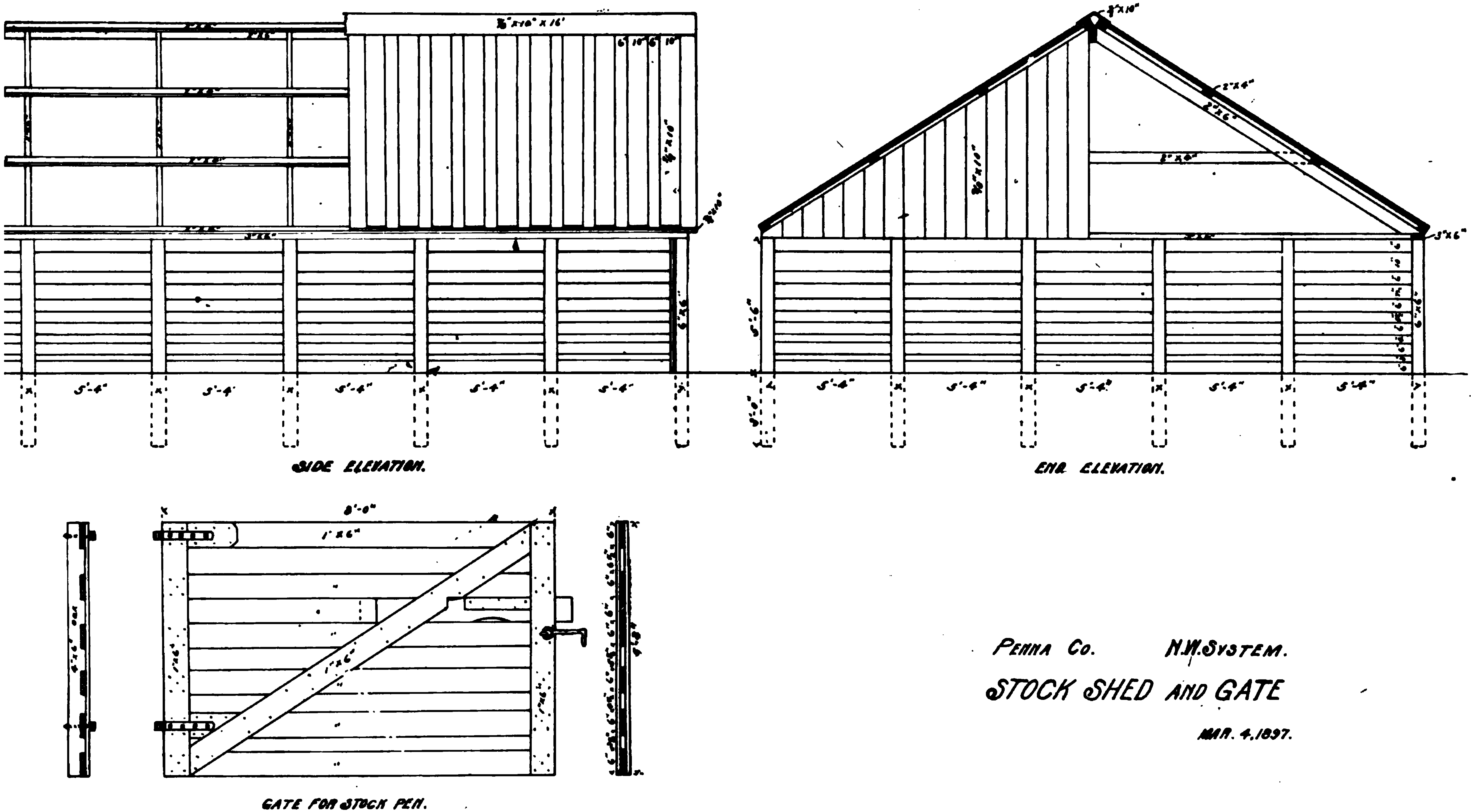


FIG. 46.—Stock Shed, Pennsylvania Company, Northwest System. (Plan No. 22, Committee Report on "Stock Yards and Stock Sheds.")

FIG 47 Stock Corral, Southern Pacific Railroad (Plan presented by Mr John D Isaacs)

DISCUSSION.

Mr. Isaacs.—We have had a great many complaints from shippers about having cattle injured from the sharp corners of the yards, so that we make all corners round. We use a double thickness of ½ x 8-inch boards around all corners. This method of construction is shown on the plan for our Standard Stock Corral on the Southern Pacific railroad. (See Fig. 47.)

Mr. Carmichael.—We have a great many stock-yards, all kinds and sizes. The size and shape of our yards depend largely on the amount of land we have to build on and the amount of stock to be handled. We also have a standard stock-yard that we build, with a platform 6 x 24 feet in front of the loading chute, and extension gates that swing from the chute post to the car door. The platform apron is also so constructed that it will slide two feet either way, which makes it more convenient about placing cars at the chute to load or unload. Shippers, generally, like this arrangement.

Mr. Isaacs.—We tried swinging gates and abandoned them. They got wrecked and inconvenient, and it was about as much trouble to adjust them to the car as it was the car to the chute.

Mr. Merrick.—I would like to ask the gentleman from the Southern Pacific what material he uses in building stock-yards, whether oak or pine.

Mr. Isaacs.—Pine altogether, and 8 x 8½ fence posts.

Mr. Merrick.—At Pierre, where cattle come to the road directly from the ranges, we use, for siding up the yard, oak boards 1 inch thick, nailed to cedar posts spaced 4 feet apart with 2 x 10-inch plank along top.

IX. Bridge Floors.

REPORT OF THE COMMITTEE.

To the President and Members of the Association of Railway Superintendents of Bridges and Buildings.

Gentlemen:—Railway bridge floors can be classed either as open floors, where the track is carried by timber cross-ties supported by longitudinal stringers or girders, and solid floors where the rails are supported by a tight floor either directly or with the intervention of ties and ballast. At the present day the open floor is the form of floor generally used for American railway bridges. The use of tight floors has been confined principally to bridges built in or near cities for the purpose of eliminating grade crossings of highways and railways, and the different conditions and legal restrictions governing each particular case have resulted in a great variety of designs. Your committee therefore has decided to limit this report to a discussion of the various types of open floors, as any attempt to treat fully of solid floors would make the report unreasonably long.

The accompanying illustrations have been selected from the drawings received by the committee to illustrate the different types of open bridge floors.

The ordinary functions of the floor are to support the track and transfer the load to the main trusses or girders. In addition, the floor should be so designed and built that a derailed car will safely cross the bridge.

In a paper entitled "Accidents to Railway Structures," by Mr. Thos. Curtis Clark, presented at a meeting of the American Society of Civil Engineers in February, 1871, there is a drawing showing the floor system in use at that time. Briefly described, the ties were nine feet long, with an eight-inch face and spaced fifteen inches apart in the clear. The stringers were spaced five feet centre to centre. As the result of accidents showing the necessity of providing means for carrying a derailed car safely over a bridge, the present floor has been developed.

The component parts of the floor are the ties, guard timbers and guard rails, stringers and floor beams.

The timber guard sticks outside of the rails were first used to prevent derailed wheels from running off of the ends of the ties. Mr. John D. Isaacs of the Southern Pacific Co. writes: "This timber, in case of derailment, without the use of an inside guard rail, becomes an element of danger. If any of the wheels of a derailed truck crowd against the guard timber it is very apt to slew the truck and throw the car overboard." The same fact is stated in a circular relating to guard rails on bridges, issued by the Massachusetts Railroad Commission, and a writer in the *Railroad Gazette* for 1886, page 774, states that four or five cases have come under his observation where a wooden guard stick nine inches out from the outside of the rail has been the undoubted means of at least hastening if not causing wrecks by slewing derailed trucks around on bridges.

The inside iron guard rail eight to ten inches clear of the running rail is now generally depended upon to keep derailed wheels on the ties and has already been made the subject of a report to this society.

The proper use of the guard timber is to act as a spacer for and to prevent bunching of the ties by a derailed wheel. This is accomplished by notching the guard sticks over the ties, and also fastening them to the ties by bolts or lag screws. From 1 to 1½ inches depth of notch, and

a bolt at every fourth tie for fastening has been found to be sufficient. Lag screws for fastening to ties have the advantage over bolts, that they can be used in places where it would be difficult to get at the lower end of a bolt to screw up the nut. Also, they obviate the trouble that arises from the nuts getting loose and falling off when bolts are used. On some wooden bridges the guards, ties, and stringers are bolted together with one bolt.

The guard timbers are spliced with a scarf joint and one bolt at a tie (Pl. 6, Fig. 1), or merely butted with bolts in two adjacent ties (Pl. 6, Fig. 2). The timber should be placed far enough outside of the running rail to be clear of the outside wheels of a derailed truck, when the inner wheels are running against the guard rail. With the guard rail 10 inches clear of the running rail, this will require at least 6 feet, 10 inches clear between the guard sticks. The sticks are spaced farther apart than this, generally at or near the ends of the ties, to be out of the way of snow plows.

The rails are supported by, and fastened to, the ties. The clear spacing between the ties has been decreased so that a derailed wheel running over the floor will not drop down between the ties. The spacing now used varies from 4 to 7 inches; the former being considered objectionable, as being too close.

Before the use of inside guard rails the length of tie was increased to twelve feet to keep wheels on the floor. This necessitated supporting the ties outside of the rails, as derailed wheels would break off the ends. This was accomplished either by the use of outside stringers under the ends of the ties or by increasing the spacing between the track stringers.

With the use of proper guard rails the minimum length of tie is governed by the required clear distance between the guard timbers. With sticks 8 inches wide, the length of ties would be 8 feet, 2 inches. The length of 12 feet has, however, been adopted, as it enables the guard sticks to be placed clear of everything, furnishes a convenient platform to work on in case of accident, closes the gap between tracks on a double track bridge, is an additional preventative of accident in case the wheel jumps the guard rail, and in case the guard rails are not used the greater width is necessary.

The ends of ties projecting beyond the guard sticks, as shown on several of the drawings, are waste material so far as protection from accident is concerned, and one of the double guard sticks shown on Pl. 9, Fig. 4 can be classed under the same heading.

When ties are subjected to transverse stress by placing the stringers outside of the rails, the rails serve to distribute the wheel load over three or more ties so long as the wheels are on the track. The load from a derailed wheel will come practically all on one tie, and unless considerable margin has been allowed in proportioning the tie it will be dangerously overloaded. Heavy timbers placed as near as possible to rails and bolted to every tie are sometimes used to distribute the wheel load over the adjacent ties.

The disadvantages of ties acting as beams are fully stated by Mr. Snow in his discussion accompanying this report.

To prevent the ties moving sideways, they are notched over or fastened to the stringers. On wooden bridges it is sufficient to spike the ties to the stringers with $\frac{3}{4}$-inch boat spikes without notching. On iron bridges the ties are notched from $\frac{3}{4}$ to 1 inch, and in many cases are fastened to the iron work by bolts through every third or fourth tie. Except in localities where there is danger of the floor being blown off the bridge, there does not appear to be much necessity for these bolts.

Unless greater sizes are required, due to the tie acting as beam, an

8-inch face and depth sufficient to hold the spike and allow for notching are all that is necessary,—say 6 inches for ties on wooden bridges, and 7 inches with ½-inch notch for ties on iron bridges.

Stringers and floor beams are used to support the track and transfer the load to the main girders or trusses. Their arrangement will be given in the following detailed description of the various types of floors.

1. Wooden stringers (Plates 1 and 2).

These bridges are built both with long and short ties. The main stringers are placed directly under the rail and the ends of long ties supported by side stringers. A certain portion of the load depending on the relative stiffness of ties and stringers, is carried by the side stringers. The formulas for determining this amount have been deduced and published by Prof. G. F. Swain, in the *Railroad Gazette* for 1888. The practice on the B. & M. R. R. is to put six sticks under the track, two under each rail and one each side 10 feet out to out, and consider the side stringers to carry 20 per cent. of the load.

Plate No. 1 shows the different details used for single track trestles, and Plate No. 2, those for double track. The first three examples shown on Plate 2 are objectionable, inasmuch as it is necessary to disturb both tracks at once when renewing the ties. The form of construction used by the Boston & Maine railroad allows either track to be renewed independently of the other, which is quite advantageous.

Through Wooden Truss Bridges: Plates 3 and 4.

The floor beams are either supported on top of, or are hung below, the bottom chord. The first method furnishes a direct support for the floor beams, but the deflection of the loaded floor beam brings the load on the inner edge of the chord. When the floor beams are hung below the chord, the hanger can be designed to distribute the load over the whole width of the chord. By the latter method, there is also a gain in head room over the rail, equal to depth of chord plus depth of floor beam. Another advantage of suspended floor beams is that they do not have to be cut away at the ends when near a panel point of the truss, to clear the braces.

Fig. 1, Pl. 3, is an example of the floor where the ties are used for floor beams. The clear spacing between is 7 inches. At panel points the tie has to be supported from the one each side, as shown on Fig. 1, A. The 8x8 guard stick is bolted to every tie, and aids in distributing the wheel loads. A bridge with a similar floor, recently taken down on one of the branches of the B. & M. R. R., had a 10x10 guard stick bolted to every floor beam, and a 4x4x¾ inches angle iron for an inside guard rail, also bolted to every floor beam. This evidently was more efficient in distributing the loads from a derailed wheel than the example shown.

When ties and stringers are used, the floor beams are either spaced uniformly or concentrated at the panel points, both methods being shown on Plate 4. The latter method reduces the bending in the chord to a minimum, but calls for a larger stringer. By using side stringers and considering them to carry part of the load, the bending moments, and consequently the sizes of the floor beams, will be reduced.

With suspended floor beams, the lateral bracing rests on top of the beams, and the stringers are cut on to it. When the floor beams are uniformly distributed, this will not affect the strength of the stringers; but when floor beams are concentrated, it becomes a serious matter.

Wooden Pony Trusses (Plate 5).

The floors for these bridges are similar to those for through trusses.

The manner of bracing the top chord is mentioned here, as it is affected somewhat by the design of the floor. The top chord is braced

from a collar beam fastened to the bottom chord. When the floor beams rest on top of the chord the collar beam can be bolted below the chord, and is out of the way. When the floor beams are hung below the chord, the collar beam will deflect with the floor, and throw the top chords out of line unless the collar beam is blocked down below the tops of the floor beams, as shown in Fig. 2.

In Fig. 2, the collar beam is bolted to the truss independent of the truss rods. This is preferable to the method shown in Fig. 1, as the trusses can be built complete and erected in place, and shrinking or crushing of the collar beam will not affect the adjustment of the truss rods.

Wooden Deck Trusses: Plates 3 and 6.

The floor beams rest on top of the top chord, and unless the bridge is roofed over, the arrangements and details are the same as for through bridges. The top of the top chord is protected from the weather by galvanized sheet iron, as shown on Pl. 6, Fig. 2. The bridge shown on Pl. 3 is also protected in the same manner.

With a record of service of from forty to fifty years for wooden truss railway bridges, when properly designed and protected from the weather, it would appear to be economy to cover all wooden truss bridges. This does not affect the floor for through or pony trusses, but the roof for a deck bridge makes a change in the design of floor necessary.

There are several different ways of putting a roof on a deck bridge. The example shown on Pl. 6, Fig. 1, is the standard of the Boston & Maine Railroad, and is to be recommended as protecting everything except the ties and guard sticks from the weather.

Rolled Beam Bridges (Plates 7 and 8).

Examples are given for both single and double track bridges. The arrangement of ties and spacing of stringers differ but little from wooden stringer bridges. Side stringers, when used, cannot be figured as carrying any of the load when wheels are on the rails, owing to the greater rigidity of track stringers compared with the ties.

Deck Plate Girders (Plate 9).

The usual method of construction is to place two girders under each track, the girders being spaced from 6½ to 9 feet on centres, the spacing being governed to some extent by length of span and depth of girder.

Fig. 2 shows the ordinary form of construction. The ties act as floor beams and deflecting under a load bring the reaction along the inner edge of the top flange, tending to bend it down.

Fig. 3 shows a method of concentrating the load at the centre of the flange, and preventing side movement of the ties without the necessity of notching them out the full width of the flange.

The top lateral bracing in this style of bridge should be designed so that there will be no interference with the ties.

The standard deck girder of the Boston & Maine railroad differs from the foregoing by the addition of floor beams and stringers. The stringers support the tie under the rails, and the girders, spaced nine feet centre to centre, act as side stringers for supporting the ends of ties in addition to their regular duties. There is one system of longitudinal bracing in the plane of bottom flange of floor beams. The bridges are riveted up complete in the shop, transported to the site, and put in place at a minimum cost for erection. Ties of minimum thickness are also used.

Through plate girders (Plate 10).

Fig. 1 shows the simplest floor, where the ties act as floor beams and are supported by the bottom flange angles. Mr. James McIntyre has charge of some of these bridges and writes: "This construction I

do not approve of, on account of the constant springing of the floor tending to weaken the flange angles and flange plates." The lateral bracing and ties interfere with one another, the ties bearing against and loosening the bracing.

Fig. 2 shows the method used to overcome these difficulties. The shelf angle carries the ties and there is plenty of room for the lateral bracing.

Floor beams and stringers are introduced to shorten the span of and reduce the size of the tie.

Fig. 3 shows one variety of iron flow with only two stringers, spaced 8 feet, 0 inches, centre to centre. The arrangement of ties is similar to that for a deck girder. Notching the ties is reduced to a minimum by extending the web of stringers above top of flange angles, and cutting ties on to it.

Fig. 4 shows method of supporting the ties under the rails and at the ends, the details being the same as for rolled beam bridges. The next step in the progress of development would be a solid floor.

Through Iron Truss Bridges—Plate 11.

Generally there are two stringers to a track spaced from 5 to 8 feet c. to c. and headed into the floor beams. The B. & M. R. R. uses an arrangement of stringers as shown on Fig. 4, Pl. 12.

The details of ties are the same as for deck girders, sizes being governed by spacing of stringers. At the floor beams there is a break in the continuity of the spacing of the ties, caused by the floor beam flange increasing the clear distance between the adjacent ties. This is not a very important matter, as the top of the floor beam is seldom more than two or three inches below top of tie, and a derailed wheel would go over all right and the wide space does not make a noticeable difference in riding of the track.

Wooden stringers in combination bridges are placed on top of floor beams as shown in Fig. 4.

The clear distance of 14 to 15 feet between trusses of through bridges is more than ample to keep clear of a derailed car when it is kept in place by the guard rails and has been adopted with reference to the safety of brakemen on the sides of cars. The state of Vermont requires a clearance of 15 feet for this purpose. When the tops of through girders extend above the level of a car floor they should be built with the same clearance, but shallower girders can be placed nearer the rails.

Iron Deck Trusses—Plate 12.

Fig. 1 shows an example where the ties are used as floor beams, the details being similar to deck girders.

Fig. 2 and 3 are examples of iron floors with the floor beams riveted to the posts, the top chords acting as side stringers. In Fig. 2 the lateral bracing is both in the plane of the bottom flange of the chord and of top flange of floor beam. In Fig. 3 a greater depth of truss is obtained, but the bracing which is fastened to the top flange of the floor beam is below the chord and causes bending in the post.

Fig. 4 is an example where the floor beam rests on top of the chord, the simplest and best form when the depth can be spared. The spacing of stringers and details of ties will vary the same as for through bridges.

The various methods of connecting the track on the bridge with the track on the ground at ends have been fully shown in the drawings. The timber wall plates on parapet walls are sometimes blocked up at the ends to give more elasticity. The objections to these timber wall plates are fully given in Mr. Snow's discussion before referred to.

By arranging the parapet stone as shown on the different drawings of the Boston & Maine Railroad bridges the distance between first

bridge tie and first grade tie is about the same as the distance between two ties in the ballast.

Skew Bridges—

The simplest arrangement for deck bridges is to lay the bridge ties parallel to the parapets, and fan out the grade ties. The bridge ties do not receive their load at the same time, and tend to jump and wear out more rapidly. The grade ties are either too far apart under one rail or so close together under the other that it is difficult to tamp them.

The first figure on plate 13 shows a method of keeping the bridge ties square to the track. The Union Pacific Railway treats the end grade ties in the same manner. One objection to this method is the short lengths of ties supporting sometimes only one rail and tending to work loose.

There is always somewhat of a jar when the train passes from the ballast road-bed to the more rigid bridge floor, and unless both wheels of an axle pass onto the bridge floor at the same time there is a noticeable lurch. The best remedy for this is to square up the end of the bridge floor.

For skew trestles the end bents can easily be built square. One way of squaring the floor is to have a longitudinal sill on the bank supporting the other ends of the ties which rest on one stringer only. This is objectionable, as the sill will rot and settle, and it is something that is neither bridge floor nor track, and is liable to be neglected. The best way is to square up the ends of the stringers so that the first bridge tie is wholly on the bridge and the first grade tie is wholly in the ballast. Methods of doing this are shown on plates 13 and 14.

When rebuilding skew bridges on old abutments it is very easy to make the design so that all the main bearings will be supported on the old masonry, and whatever additional masonry is necessary for secondary bearings and parapet walls, can be built with the old bank as a foundation, without danger of settlement.

In concluding their report, your committee make the following recommendations:

1. Ties 12 feet long, spaced 6 inches apart in the clear, supported directly under the rails and near the ends.
2. Suitable inside guard rails and spacers at ends of ties.
3. Squaring the floors at the ends of skew bridges.
4. Connecting bridge floor with approach by the method shown on plate 9, figure 1.
5. Making the floor independent for each of the two tracks of a double-track bridge, as shown on plate 8, figure 2.

Respectfully submitted,

BENJ. WILDER GUPPY,
Chairman.

C. P. AUSTIN,
F. W. TANNER,
Committee.

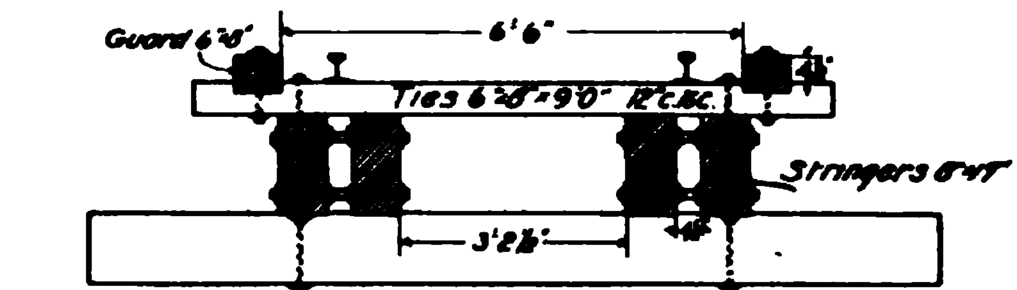


Fig 1-2 Stringer Trestle - Southern Pacific Co.

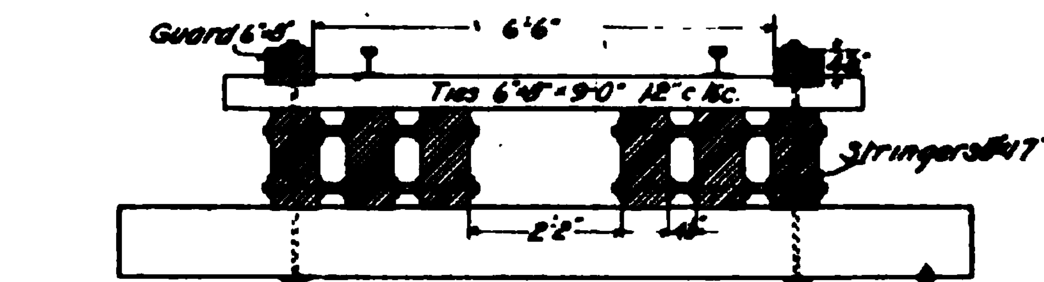


Fig 2- 3 Stringer Trestle - Southern Pacific Co.

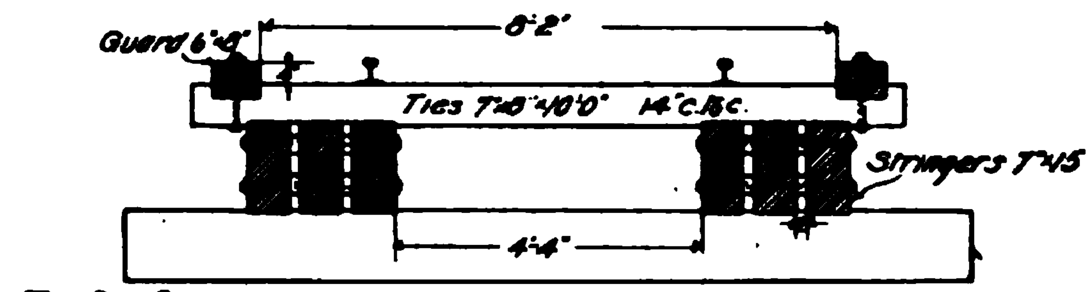


Fig. 3 - Standard Trestle - Missouri Pacific Ry Co.

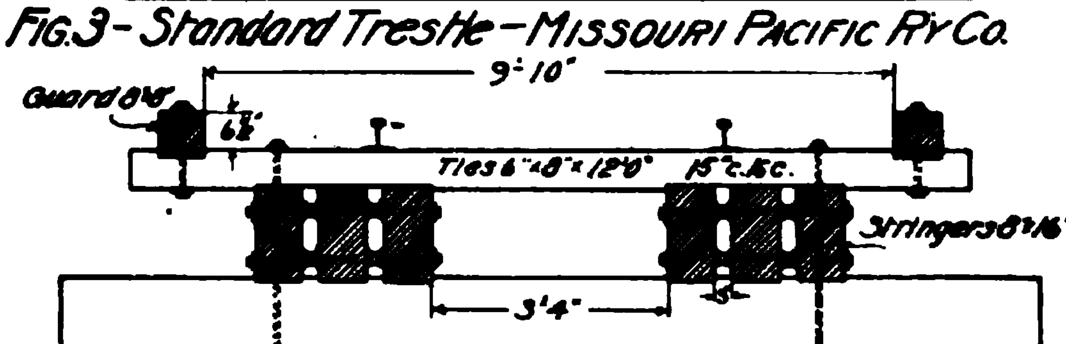


Fig 4 - Standard Trestle - Union Pacific System

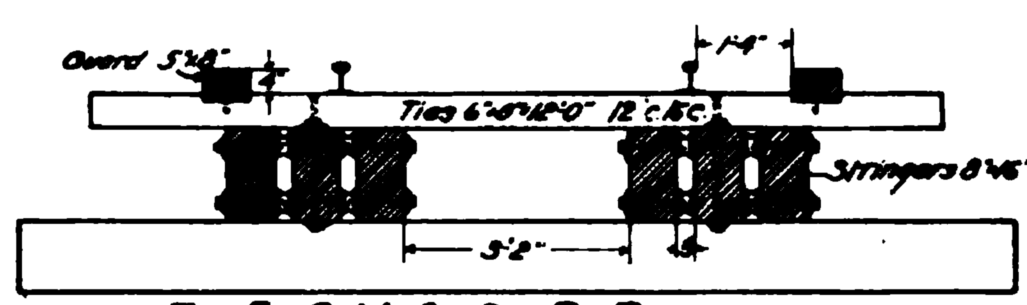


Fig. 5 - C.M. & St. P Ry.

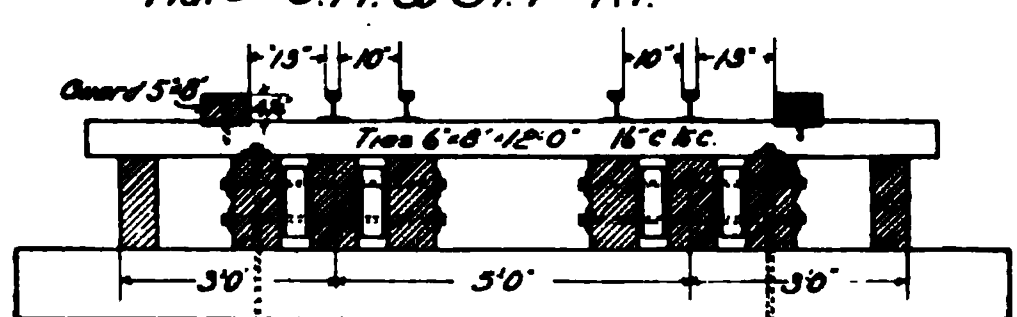
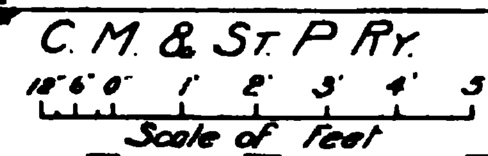


Fig 6. C.M. & St. P Ry.



Single Track Trestle Floors

PLATE 1.

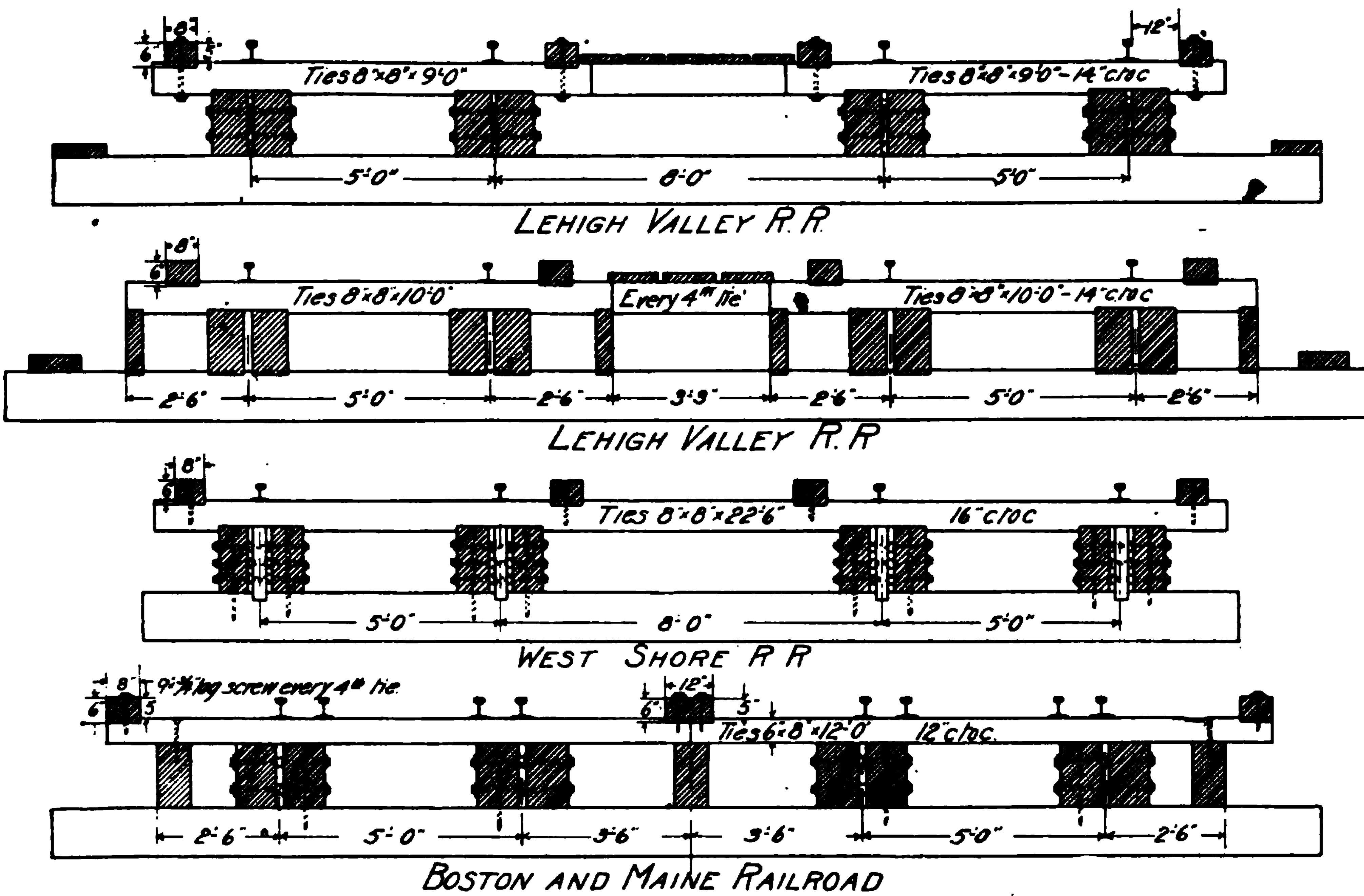

Ties 8"x8"x9'0"
Ties 8"x8"x9'0"-14"c/to c
5'0"
8'0"
5'0"
LEHIGH VALLEY R.R.
Ties 8"x8"x10'0"
Every 4th tie
Ties 8"x8"x10'0"-14"c/to c
2'6"
5'0"
2'6"
3'3"
2'6"
5'0"
2'6"
LEHIGH VALLEY R.R
Ties 8"x8"x22'6"
16"c/to c
5'0"
8'0"
5'0"
WEST SHORE R R
Ties 6"x8"x12'0"
12"c/to c.
2'6"
5'0"
3'6"
3'6"
5'0"
2'6"
BOSTON AND MAINE RAILROAD

PLATE 2.

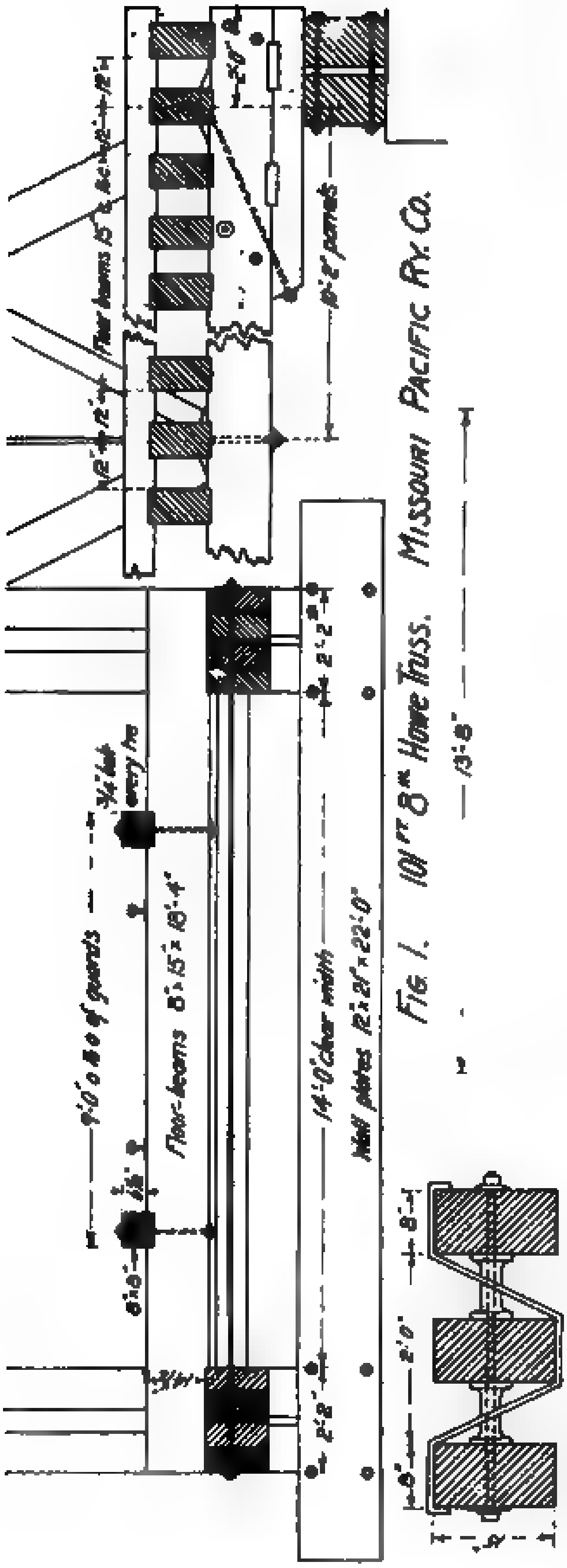


Fig 1. 101 FT 8 IN Howe Truss. Missouri Pacific Ry. Co.

Fig 2 No 13 Lebanon Br. Missouri Pacific Ry. Co.

PLATE 3.

PLATE 4.

12

Fig.2 - Ellmore Brook Bridge — St. J. and L. C. R.R.

PLATE 6.

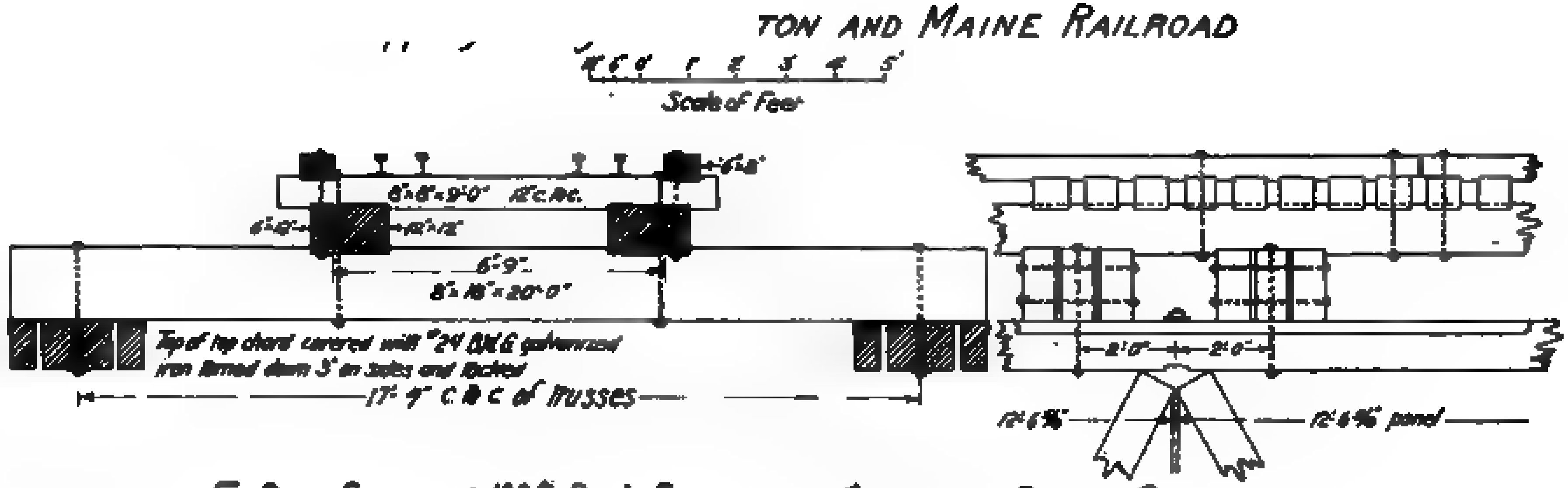


Fig. 2 Standard 100# Deck Span SOUTHERN PACIFIC Co.

PLATE 6.

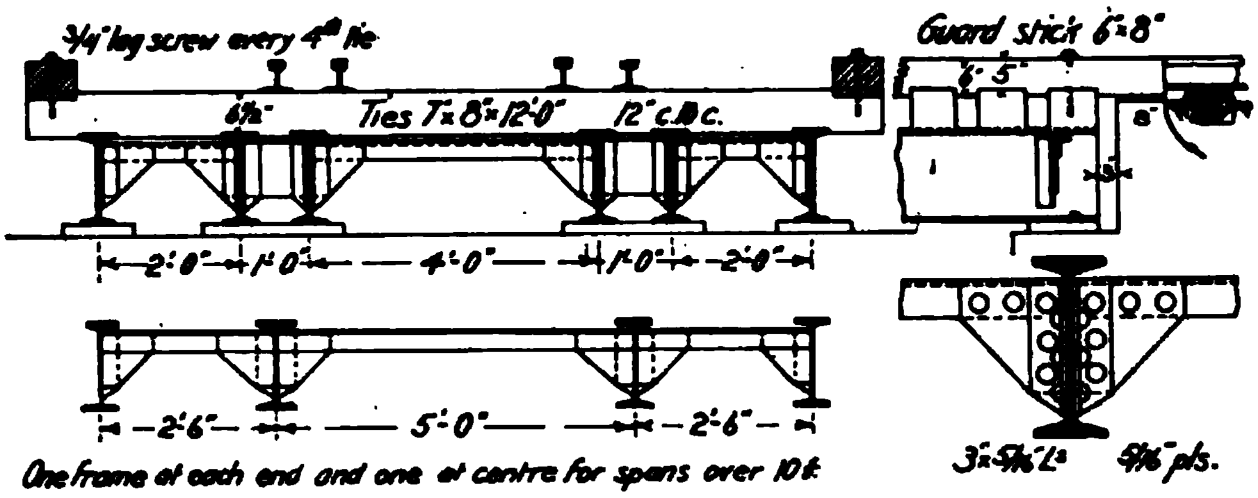


FIG. 1 BOSTON AND MAINE R. R.

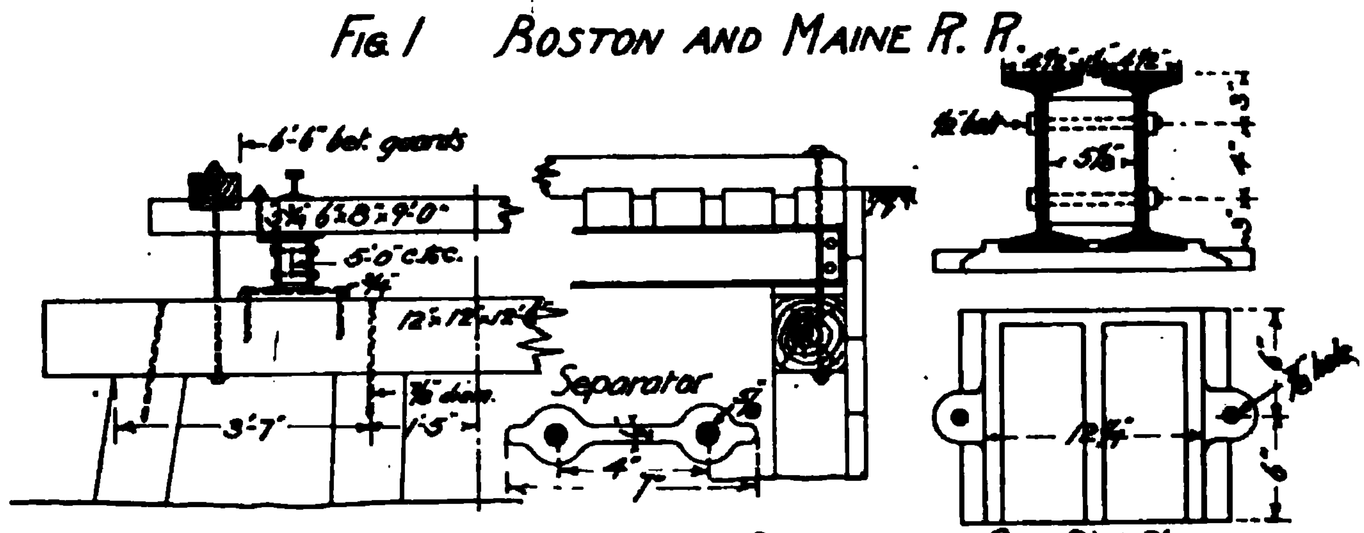


FIG. 2 SOUTHERN PACIFIC CO.

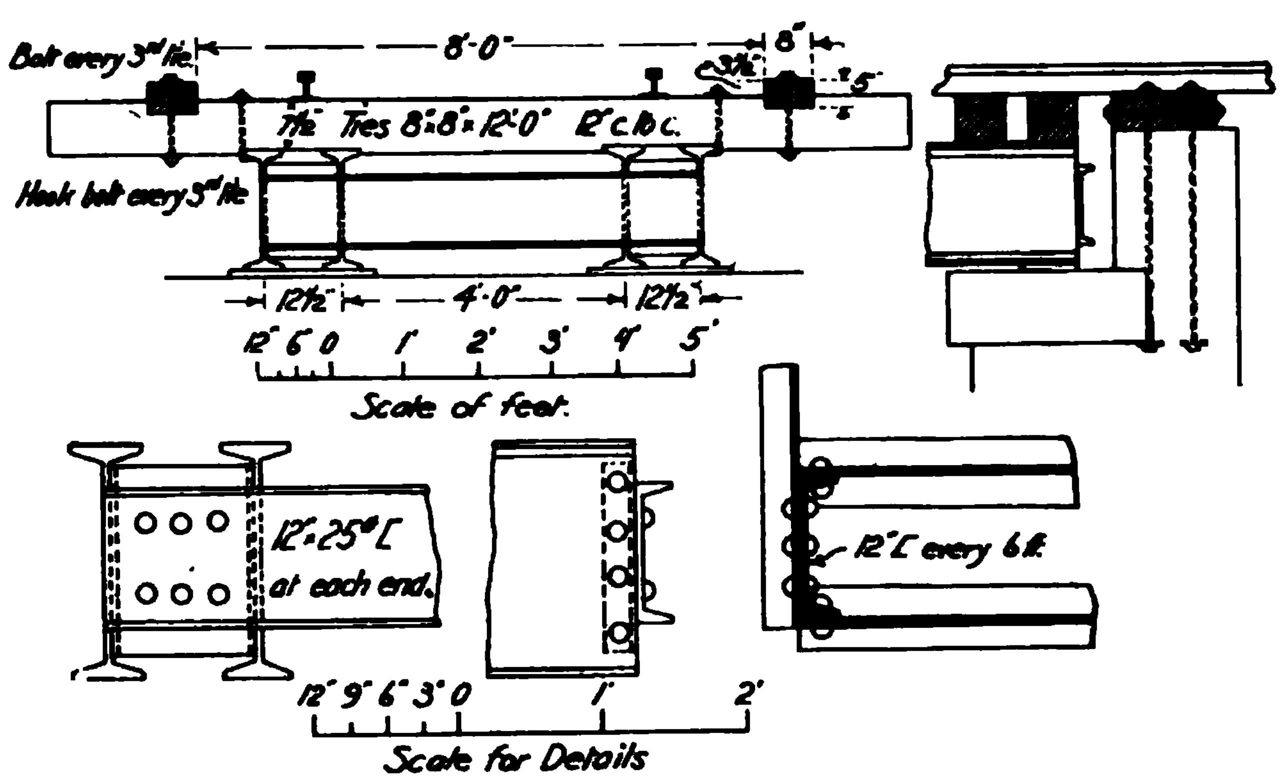


FIG. 3 UNION PACIFIC SYSTEM WYOMING DIV.

PLATE 7.

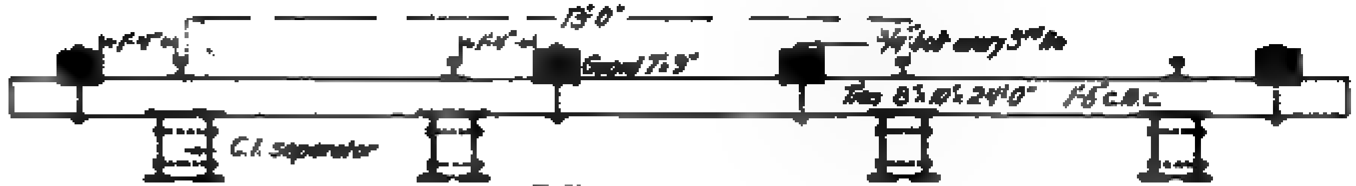


Fig. 1. WEST SHORE RAILROAD Buffalo Division

Fig. 2 BOSTON AND MAINE RAILROAD Double Track

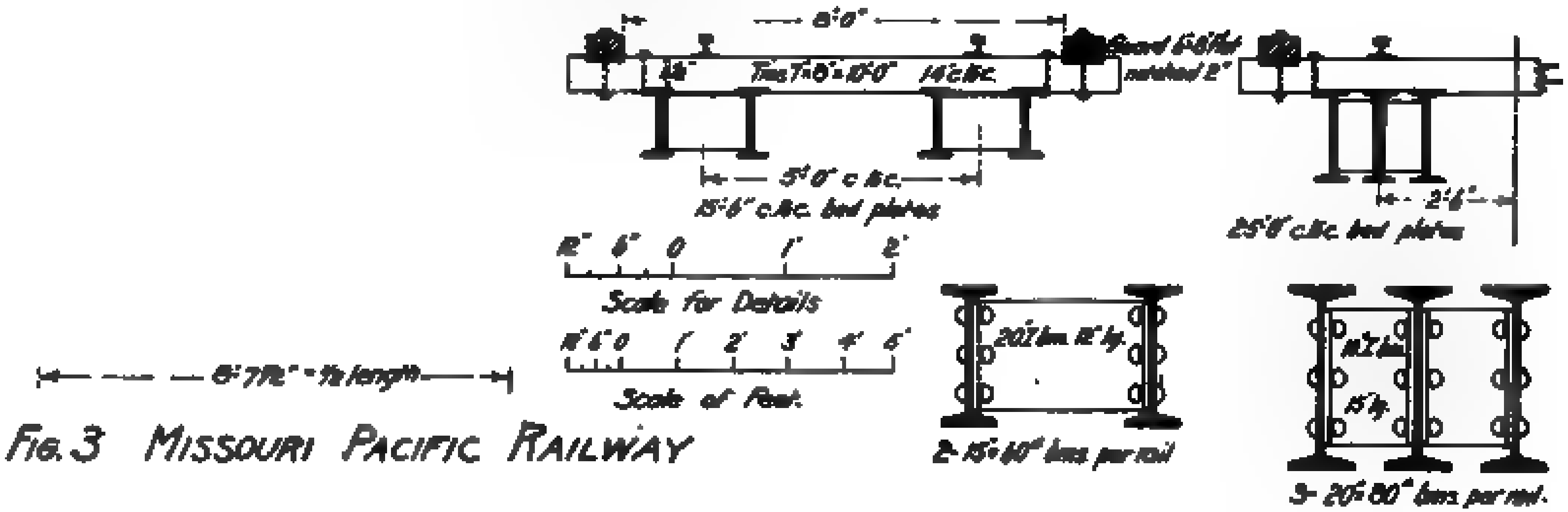


Fig. 3 MISSOURI PACIFIC RAILWAY

PLATE 8.

Fig. 1. Standard Deck Girder Boston and Maine Railroad

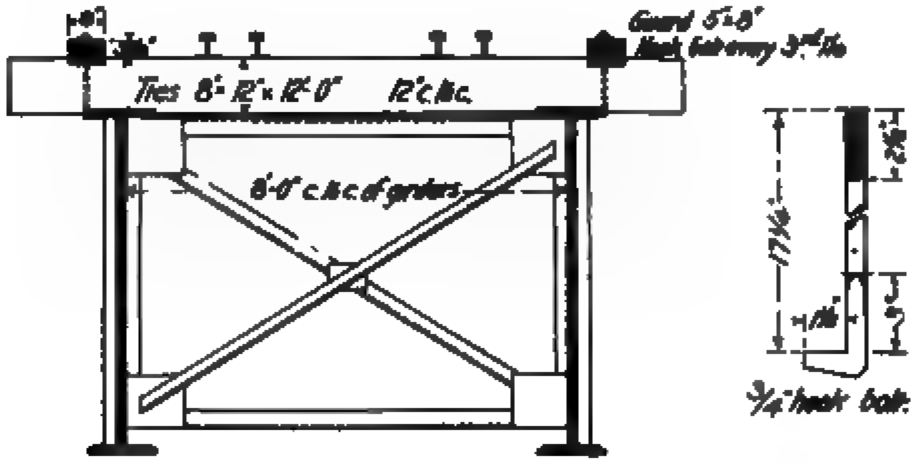


Fig. 2 Union Pacific System Wyoming Division

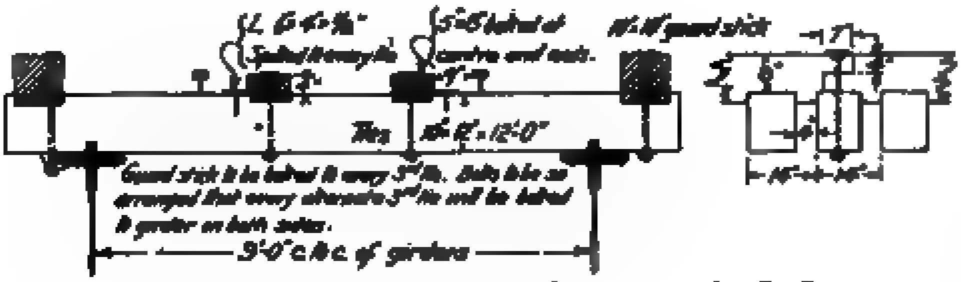
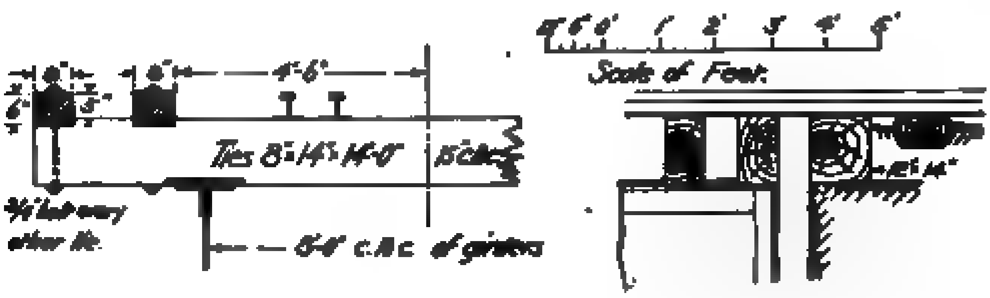


Fig. 3 Crockett Creek Bridge C. M. and St. P. Ry.



Wabash R. R.

PLATE 9

Fig. 1

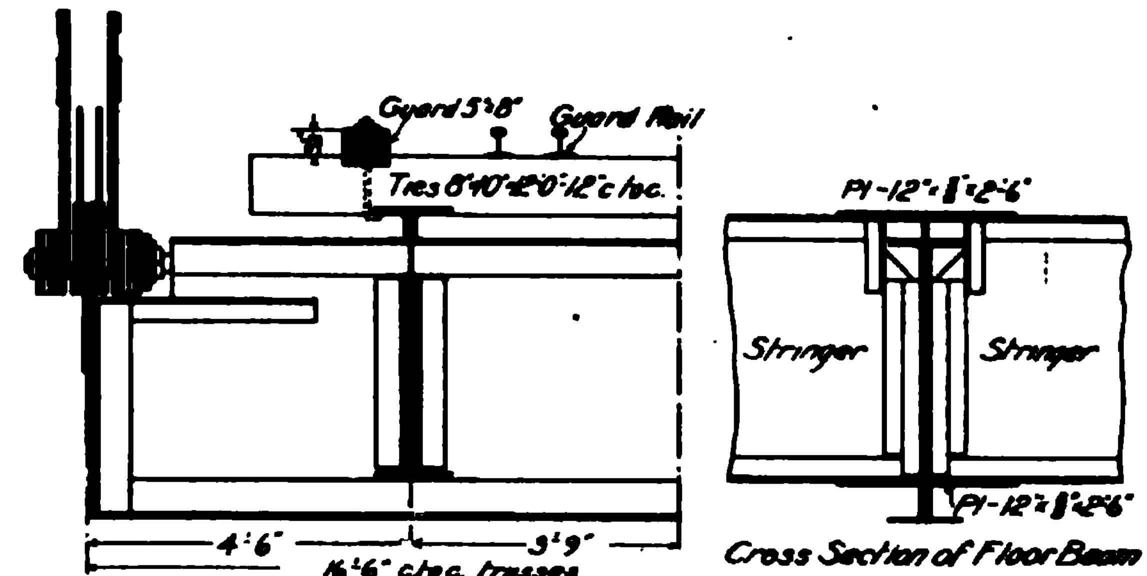
Bridge No. 643 Nashua and Acton R.R.

0 1 2 3 4 5

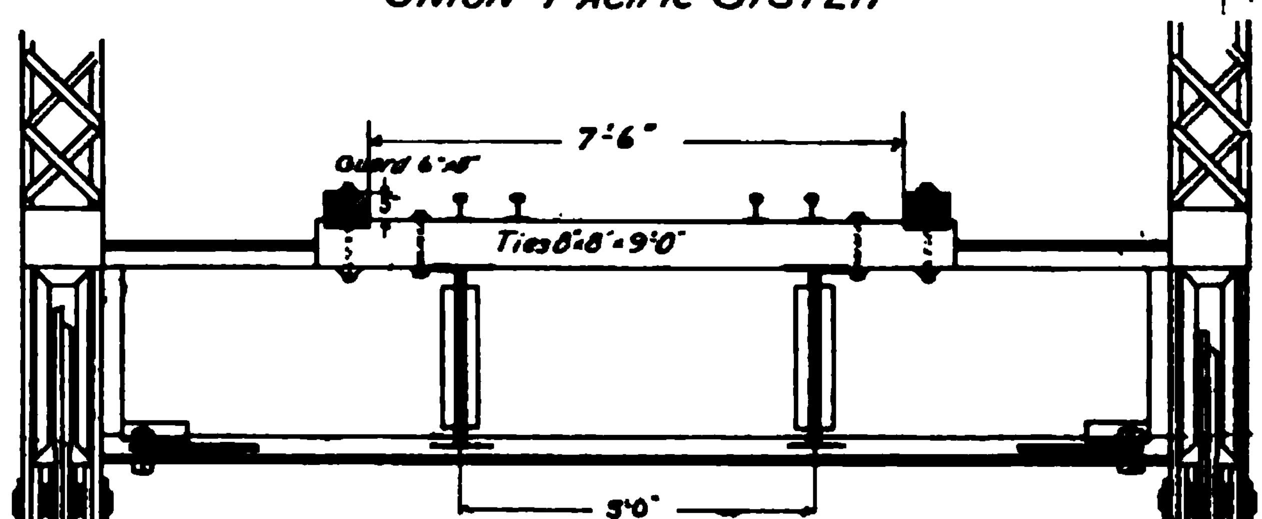
Scale of feet.

Chicago, Milwaukee and St. Paul Ry.

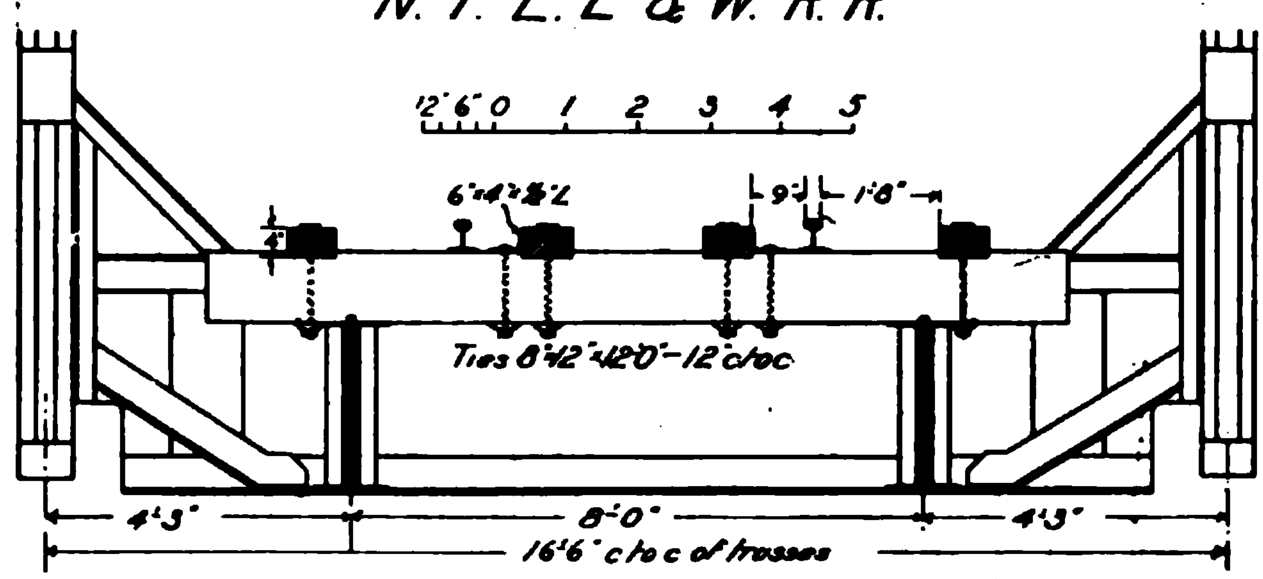
PLATE 10.



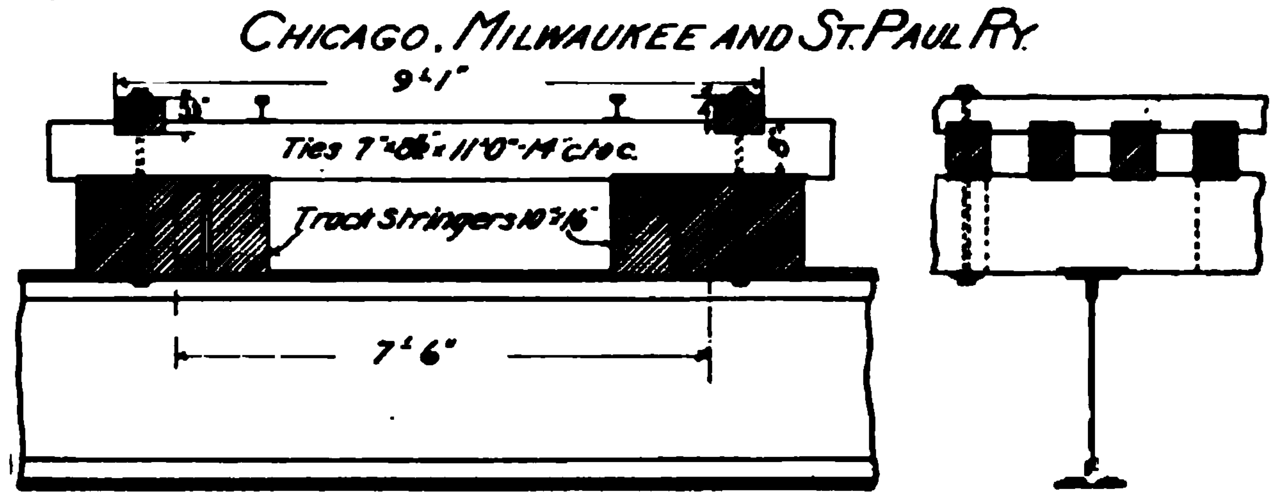
UNION PACIFIC SYSTEM



N. Y. L. E. & W. R. R.



CHICAGO, MILWAUKEE AND ST. PAUL RY.



COMBINATION BRIDGE — MISSOURI, PACIFIC RY CO.

PLATE 11.

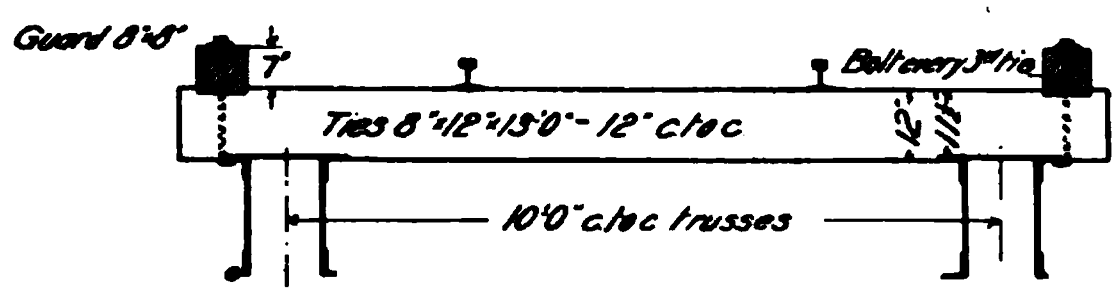


FIG 1-STANDARD DECK TRUSS - C. & O. RY.

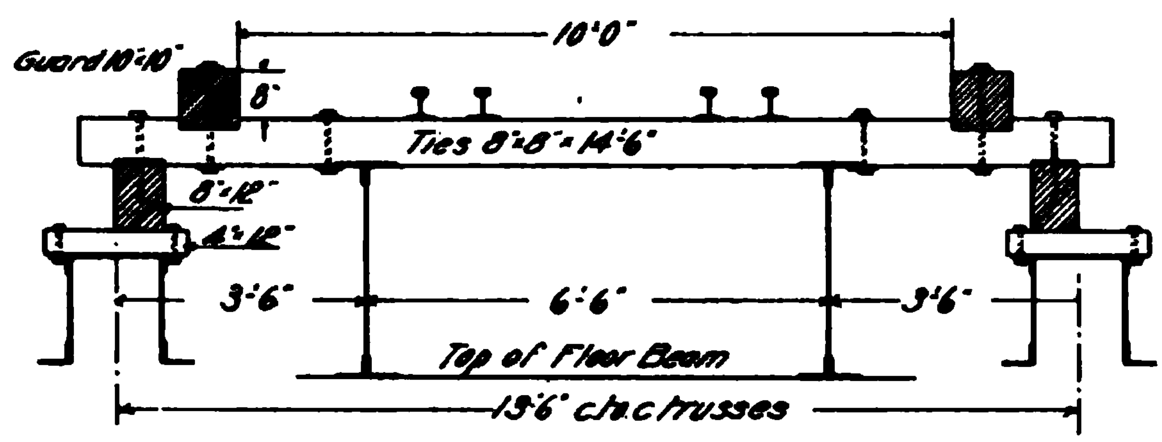


FIG 2- MANCHESTER BRIDGE - M. & N.W. R.R.

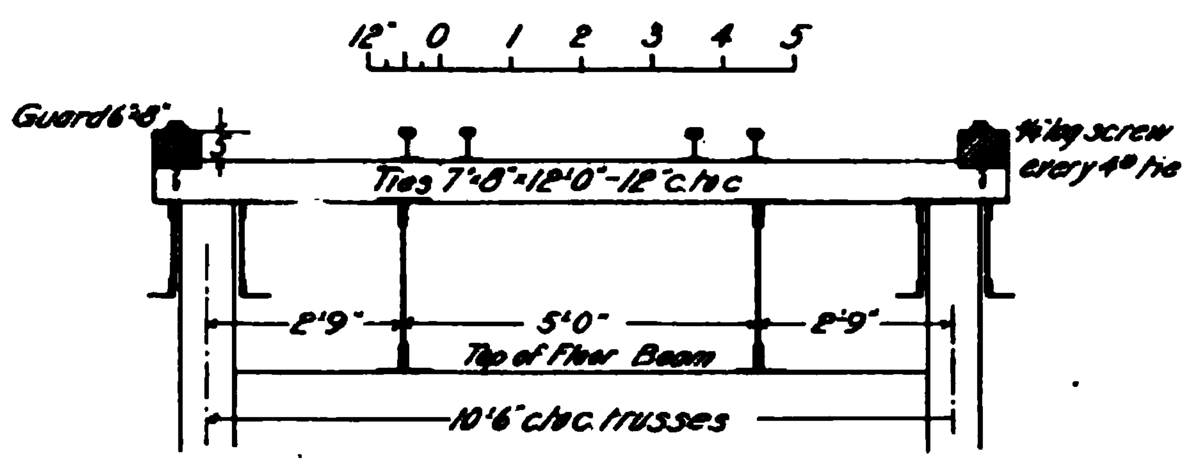


FIG 3- DECK TRUSS - B. & M. R.R.

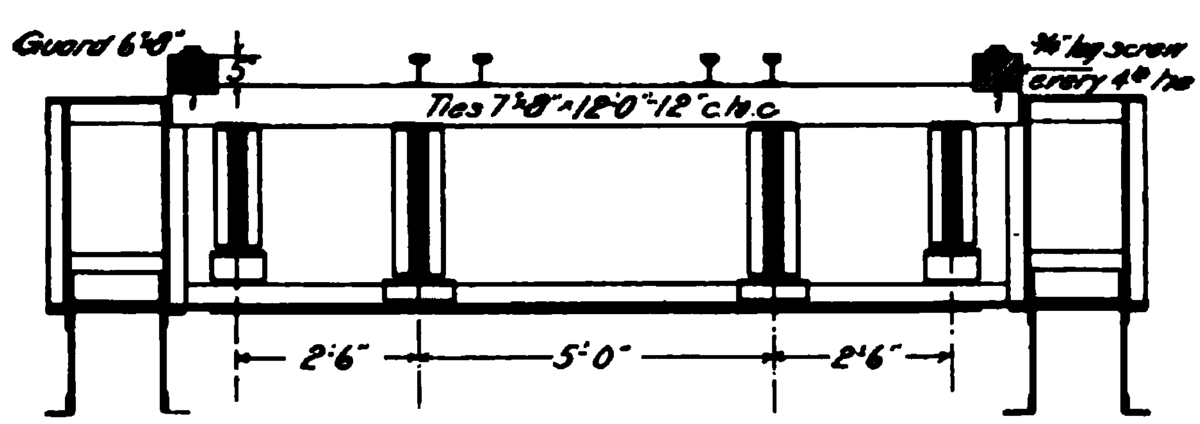
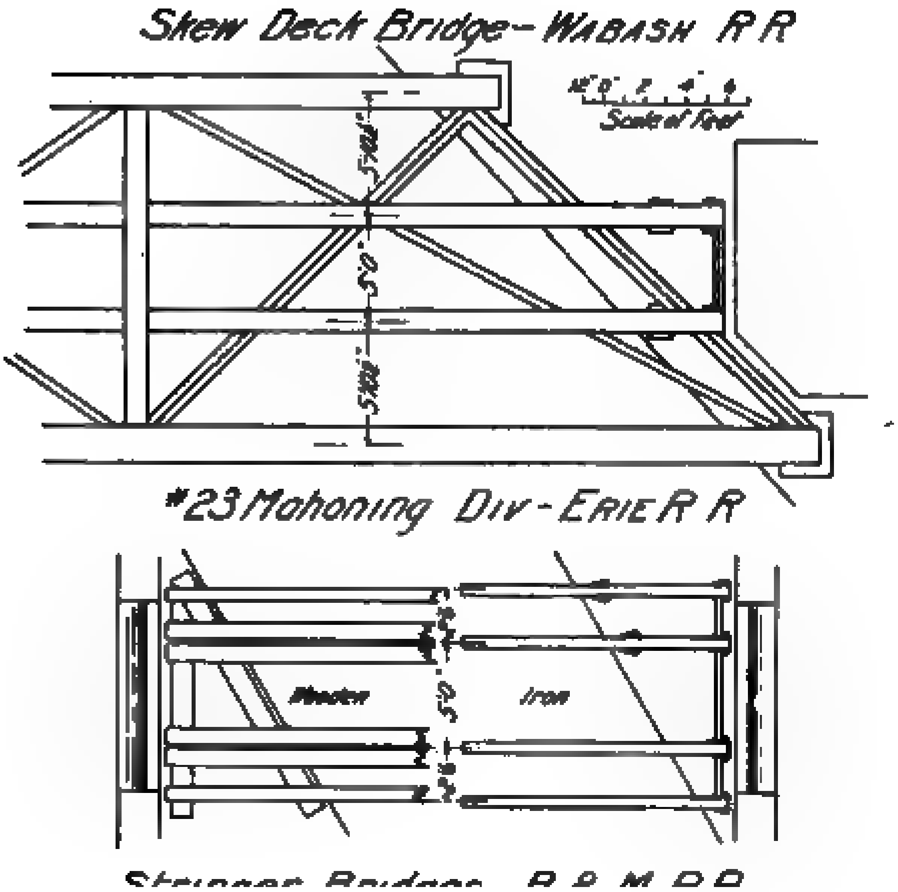


FIG 4- B. & M. R.R.

PLATE 12.



Thro Howe Truss – B. & M. R. R.

PLATE 13.

MANCHESTER ST LAWRENCE B AND M R R

FLETCHER BRIDGE - BOSTON AND MAINE R R.
Thro. Pratt Truss - 176'0" c. to c. End Pins.

PLATE 14.

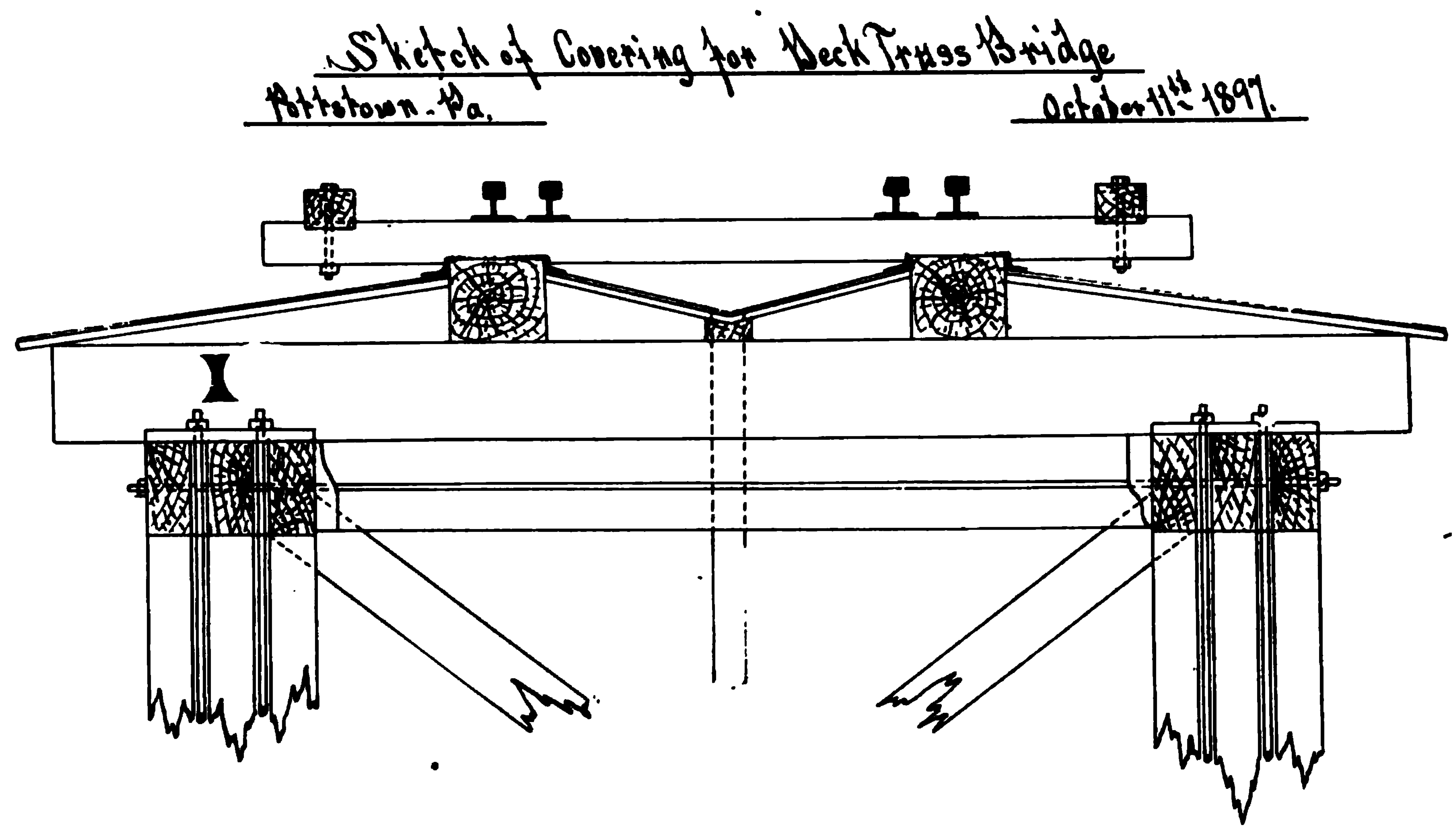


Fig. 48.—Plan of Covering for a Deck Truss Bridge, recommended by Mr. John Foreman (Philadelphia & Reading R. R.).

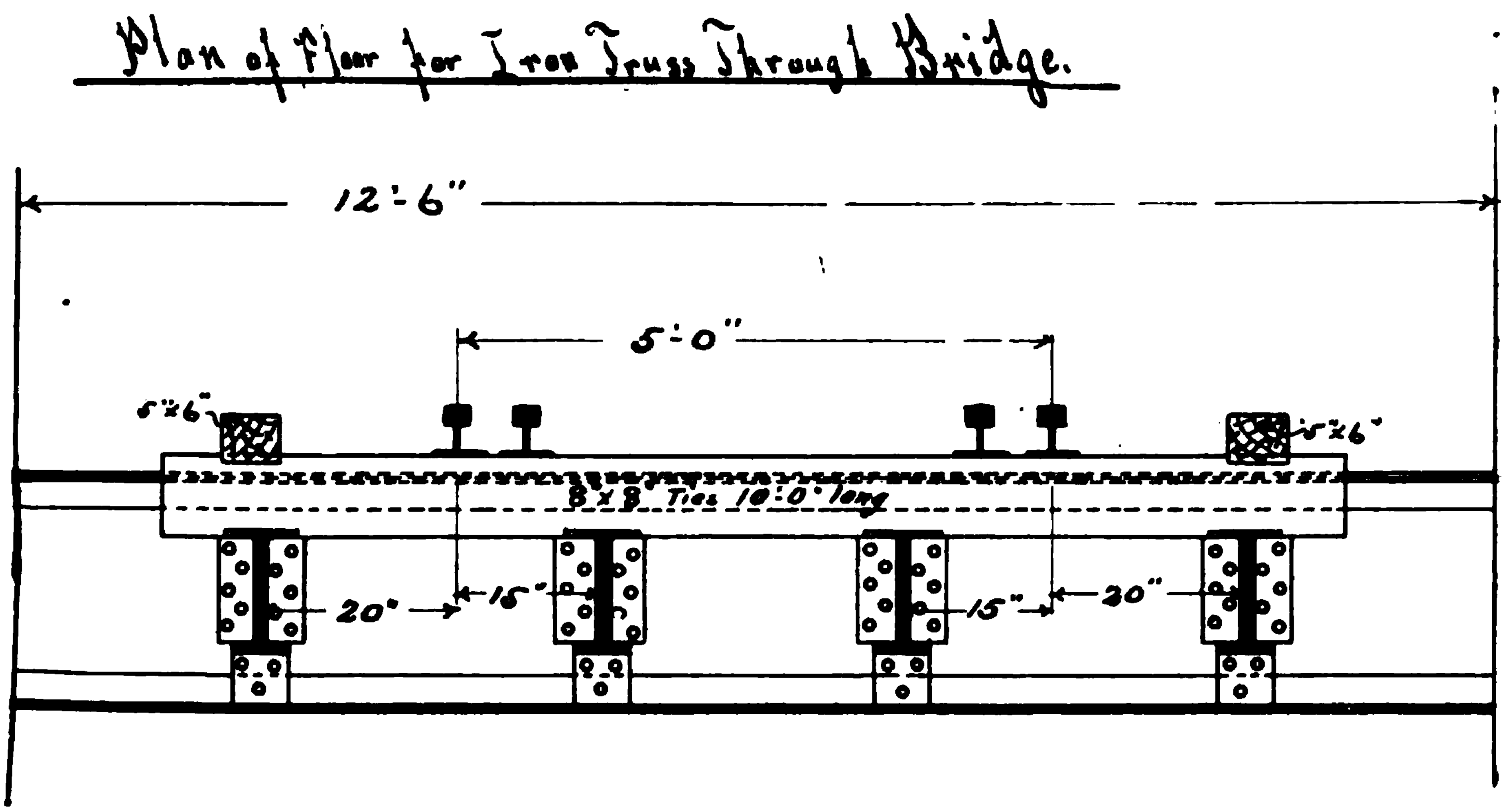


FIG. 49.—Plan of Floor for an Iron Truss Through Bridge, recommended by Mr. John Foreman (Philadelphia & Reading R. R.).

DISCUSSION.

Mr. Benj. W. Guppy, Melrose, Mass.:

DEAR SIR:—Your circular of May 17 received and noted. Replying, beg to say I herewith hand you three blue-prints and two sketches showing different styles of floors for wooden and iron through and deck railroad bridges and roadway bridges. (See Figs. 48 and 49.)

The durability of the floor depends entirely on the location; for instance, an iron floor on an overhead bridge is not as good as a wooden floor on account of the deterioration of the metals caused by the action of the sulphur from the engines.

As to the best plan of floor, I will leave it to the association to decide, but I consider where stringers and ties are used that two longitudinal stringers under each rail with 8″ x 8″ ties laid close enough so as prevent them bunching, should the cars get off the track, makes the best and most economical floor system; some of our railroad bridges have this style floor and are very satisfactory.

At present, on most railroads 9″ x 12″ ties and one stringer under each rail is used. I consider using the 9″ x 12″ ties there is a great waste of timber, and is not as safe as when two stringers are laid under each rail and 8″ x 8″ ties laid 6″ apart are used. I think the floor system of all bridges should be arranged so as not to be overloaded with ties, especially iron bridges, as tie timber is getting scarce, poor in quality, and expensive.

All iron floor systems for railroad bridges are intended to be filled up with ballast and for roadway bridges with concrete or paved. The cost of floors depends entirely on the style, width of bridges, and weight they have to carry.

Please excuse this delayed report. I am

Yours truly,
JOHN FOREMAN,
Supt. of B. and B.

J. R. Worcester, C. E., of Boston, Mass., kindly forwarded the following written discussion on "Bridge Floors."—On the second page of the report the committee speak of it being a common practice on iron bridges to fasten the floor to the iron work by bolts through every third or fourth tie, and add the following remarks:

"Except in localities where there is danger of the floor being blown off the bridge, there does not appear to be much necessity for these bolts."

Under certain circumstances, there may be another use for these bolts besides holding the floor down against the wind. When the ties project outside of the stringer or girder sufficiently, so that a derailed truck resting on the ends of the ties might raise the floor from the opposite stringer, it is possible that this disastrous result might occur, were the floor not bolted to the iron.

An actual case where it seems to have happened in this way, was at a bridge on the Fitchburg Railroad, over the Nashua river, near Ayer Junction, Mass. About a mile west of the spot, a few years ago, a box car near the middle of an east-bound freight train became derailed.

For some distance, the wheels followed close to the rails, as was plainly shown by marks on the ties, but as the train approached the bridge, the trucks of the derailed car gradually drew away from the rails so far that on reaching the bridge, the wheels were outside of the guard rails, or at least were far enough out so that in striking the guard rails they mounted and crossed over them, and the car was thrown off the side of the bridge.

In this case, the bridge consisted of two spans of deck-plate girders, the girders being six feet apart on centres, and the guard-rails consisted of a single line of steel rails like the track rails, placed outside of the latter, and deflected outward on the approach to a distance of eighteen or twenty inches from the running rail.

No inside guard-rails were used, and the ties were not bolted to the girders at all, though they were probably notched on over the flange to some extent.

Under these conditions, it appears that when the derailed car went over the side of the bridge, it broke loose from both the car in front and the one behind, but the weight coming down on the ends of the ties upset the floor, a large section of which followed the car into the river, leaving the bridge in place without any floor.

The following cars ran into the gap, the wheels apparently cutting through the lateral bracing, of which there was only a top system. The result was the entire collapse of the bridge, and the rear portion of the train was piled in a heap in the river.

While this account is given as if the facts were established, the evidence of the order in which the events occurred is only such as could be obtained from the conditions after the accident, as there were no eye-witnesses of the failure of the bridge, except, possibly, one man who was buried under the wreck.

We cannot, therefore, be sure that the causes of the collapse

were those described. It is very difficult to see, however, any other way in which the lateral bracing could have been cut through as it was, and to account for the position of the track and the ties as they appeared in the wreck.

It is also very plain that the derailed car must have landed on the ends of the ties as described, and it seems entirely reasonable to suppose that the floor, being unattached to the bridge, would have tipped up under these circumstances.

While the spacing of girders of six feet is less than that shown in most of the diagrams in your committee's report, it appears to the writer that the same result might follow from a bad derailment in the case of floors such as are shown in plate 7, fig. 3; plate 8, fig. 3; plate 9, figures 1 and 4, were it not for holding-down bolts. It would, therefore, seem well for this use of the bolts to be recognized.

The following written discussion was received from Mr. J. P. Snow:

The governing principle of the standard bridge floor on the Boston & Maine railroad is a main stringer directly under each rail, and a side stringer near the ends of the ties, as is shown on the drawings accompanying Mr. Guppy's report; the idea being to make a floor that will be perfectly safe for the passage of a train whether on or off the rails.

A great many designers place the stringers six feet or more apart, using main stringers only. In this case the ties are called upon to act as beams to carry the wheel load to the stringers. The legitimate office of the ties, is to hold the rails to gauge and line, and if the stringers are directly under the rails this is all they are called upon to do while the trains are on the rails. In this case the ties can be safely left in the track as long as they are sound enough to hold the spikes. If, however, the ties are depended upon to act as beams they must be renewed before they show much decay. Again, a tie eight inches wide and deep enough to properly take the spike is ample if the stringer is under the rail, while if used as a beam it must be proportioned for the span and will be larger in any case than those shown on the drawings referred to. This increase of size and shortening of life is a matter of serious expense.

The ties must be renewed every ten or fifteen years, and the increased expense of the beam ties will go far towards paying for the additional side stringers.

Our ties are twelve feet long with guard timbers or tie spacers flush with the ends of ties. If the guards are set in much nearer the rail than this, they will get scored by the snow plows, and a shorter tie would leave a gap between tracks in case of double track bridges. Where no side stringers are used, the overhang of ties of this length is objectionable unless the main stringers are spaced very wide. In case of derailment, the overhanging ties are liable to break under the wheels, and at all times they give the bridge a very weak appearance. The most feasible remedy for this objectionable state of affairs appears to be the use of side stringers near the ends of the ties and main stringers directly under the rails. The side stringers may be designed of about one half the strength of the main stringers, and in wooden bridges may be considered to carry, I think, about twenty per cent. of the load. The distribution of load between the main and side stringers is, of course, dependent on the relative deflection of ties and stringers, and in iron bridges the stringers are so much more rigid than the wooden ties that I think the main stringers should be calculated to carry the whole rail load.

Our deck plate girders over thirty feet span are constructed as shown on figure one, plate nine, of Mr. Guppy's report; the girders performing the office of side stringers. This style of bridge is not so much more expensive than a plain deck girder as might be supposed, for the floor does duty as lateral bracing to a large extent. At present prices it costs about four dollars per foot more than the usual pattern; that is, about two sets of ties. I think the bridge is well worth the difference in the cost.

I am aware that the great majority of roads and engineers use wide spacing for main stringers, but it seems to me to be asking the rapidly decaying ties to do the duty that the iron-work ought to perform and to be a method of cheapening the structure, better only in degree than the old-fashioned style of timber ties resting on stringers built into the bottom chords of through-truss bridges.

In regard to the spacing of ties, our practice is twelve inches on centers, leaving four inches clear between ties. Personally I would make this two inches more. A four-inch space makes a weak joggle on the guard timber for spacing the ties, and it is just the right width to let a workman's boot through, while it is difficult to get it out again. I have heard of one case where a man lost his foot from this cause. Six-inch spacing will carry derailed wheels without any tendency to bunch the ties; it gives a fairly strong joggle and will not act as a trap to catch a man's boot.

The stringers of all bridges large and small, wood and iron, are extended at the ends of the bridge to bring them square. This I consider absolutely essential to a good bridge. It involves a little additional expense on the masonry when the skew of the bridge is very great, but its cost is more than repaid in the future maintenance of the approaches. The parapet stone should not be more than eight inches wide on top so that the first ground tie will not be more than two feet from the last bridge tie c. to c. In square through bridges it is not our practice to use end floor beams, as advocated by many. We have no trouble from resting the stringers on properly designed bearing on the stone work. An end floor beam is a good detail, provided brackets are put on the land side of it so a tie can be placed near the stone parapet, and so as to leave space between it and the stone to make it accessible for painting.

Our practice, as shown on the drawings, is to bring the parapet stone within one and one-half inches of the rail. I do not like the common practice of putting a tie or other timber on the stone. The ballast lies against it, gets under it and rots it out quickly. The section men cannot renew it properly and it is generally in bad condition long before the regular bridge ties need renewing.

Table showing comparative service of different kinds of rope used for hammer line on Road Pile Driver No. 2.

Kind of rope	Size of Rope	No. of Ply Rope	Length of Line used	Total weight of rope	No. of Piles driven	No. Lin. ft. of Piling Handled	Average depth driven	Total Lin. ft. driven in ground	Cost of rope per pound	Total Cost 125 ft. of Rope	Av. cost of rope per Pile driven	Remarks
Hunts Stevedore	1 1/2"	4	125 ft.	95#	132	4727	20 ft.	2640	13¢	$12.35	9 3/10¢	Badly cut & worn, not worth splicing
" "	1 1/2"	4	125 ft.	95#	131	5835	20 ft.	2620	13¢	12.35	9 7/10¢	" " " " " "
" "	1 1/2"	4	125 ft.	95#	138 / 16	5505 / 568	20 ft.	2760	13¢	12.35	8 95/100¢	Spliced after breaking and drove 16 more piles
					154	6073	20 ft.				8¢	including the extra 16 piles
Ajax Transmission	1 1/2"	4	125 ft.	93 1/2#	182	6214	20 ft.	3640	12 1/2¢	11.69	6 4/10¢	worn too badly to be spliced
Common Manilla	1 1/2"	3	125 ft.	74#	101	4289	20 ft.	2020	6 1/2¢	4.81	4 3/4¢	" " " " " " " Hardest driving
	1 1/2"	3	125 ft.	74#	109 / 57	3630 / 1242	20 ft.	2180	6 1/2¢	4.81	4 4/10	Spliced after breaking & drove 57 more piles
					166	4872	20 ft.	3320			2 9/10	Including the extra 57 piles

Note — Drum of Pile driver friction engine is 14 inches in diameter, the sheave at front of pile driver is 20 inches in diameter, sheave on top of leads of pile driver is 14 inches in diameter — Weight of hammer = 3000 pounds

Geo. J. Bishop
Supt. B. & B.

Comparative statement showing the cost of driving piles if the Manilla rope should weigh more than 74 pounds to 125 feet, in comparison with Stevedore and Ajax Transmission rope.

Kind of rope	Size of rope	No. of Ply Rope	Length of line used	Total weight of rope	No. of Piles driven	No. Lin. ft. Piling Handled	Average depth driven	Total Lin. ft. driven in ground	Cost of rope per pound	Total Cost 125 ft. of rope	Av. cost of rope per Pile driven	Remarks
Common Manilla	1 1/2"	3	125 ft.	80#	101	4289	20 ft.	2020	6 1/2¢	5.20	5 [illegible]¢	Line worn too badly to be spliced
" "	1 1/2"	3	125 ft.	85#	101	4289	20 ft.	2020	6 1/2¢	5.53	5 47/100¢	" " " " "
" "	1 1/2"	3	125 ft.	90#	101	4289	20 ft.	2020	6 1/2¢	5.85	5 79/100¢	" " " " "
" "	1 1/2"	3	125 ft.	95#	101	4289	20 ft.	2020	6 1/2¢	6.18	6 11/100¢	" " " " "
" "	1 1/2"	3	125 ft.	80#	166	4872	20 ft.	3320	6 1/2¢	5.20	3 4/10¢	including 57 piles driven after line was spliced
" "	1 1/2"	3	125 ft.	85#	166	4872	20 ft.	3320	6 1/2¢	5.53	3 1/3¢	" " " " " " "
" "	1 1/2"	3	125 ft.	90#	166	4872	20 ft.	3320	6 1/2¢	5.86	3 1/2¢	" " " " " " "
" "	1 1/2"	3	125 ft.	95#	166	4872	20 ft.	3320	6 1/2¢	6.18	3 3/4¢	" " " " " " "

Geo. J. Bishop
Supt. B. & B.

FIG. 50.—Pile Hammer Rope Tests, made by M. Geo. J. Bishop, on the Chicago, Rock Island & Pacific Railway.

X. Pile-Hammer Ropes.

REMARKS BY MR. GEORGE J. BISHOP AND DISCUSSION.

Mr. Bishop.—At our last meeting there was some discussion brought up in relation to the different kinds of ropes used for pile-drivers. One of the members stated that the stevedore rope was the best rope in use, and gave perfect satisfaction after long service. On the strength of that statement, I ordered a coil of stevedore rope, to give it a test. When we had our executive committee meeting in Chicago, March 10th, last, a firm gave me 125 feet of 1½ in. Ajax transmission rope, for trial, provided I would make a report of same. But since giving me this rope, this same firm claim that they have made a great improvement in the Ajax transmission rope, which they think would make it more satisfactory than the rope they gave me for trial.

You will note that manilla rope usually weighs about 72 pounds to 125 feet. One of the manilla ropes that I tested weighed only 66½ pounds. For a comparison of cost with the first line, as this rope weighed 80 pounds and the number of piles driven was 101.

I made a series of tests, and present two tables giving the results (see tables, Fig. 50) and will state that the conclusions arrived at as the result of these tests of 1½ inch pile-driver rope was that everything was in favor of the manilla rope.

Mr. Berg.—I understand from Mr. Bishop that these two tables show that the tests were made on the basis of respective cost and actual service in driving piles. That further certain variations or fluctuations as to the weight of each particular rope would vary the actual results reached as far as figures go, but that such variations within reasonable limits will not change the general conclusion reached, which is decidedly in favor of common manilla rope in place of Ajax transmission rope or Hunt's stevedore rope as far as pile-driving work is concerned. That is the valuable result that these tables show. I may add that I think Mr. Bishop has honored this association by publishing such valuable data through the agency of this association. He has gone into the question most thoroughly and

systematically, and it is just such information that the technical railroad world is anxious to obtain.

Mr. Carmichael.—I would like to ask Mr. Bishop if the condition of the weather was the same during the tests made of the different ropes. The weather would have considerable to do with the lasting qualities of the ropes.

Mr. Bishop.—We had two ropes of one kind, manilla; and three ropes of the stevedore. When making these tests, it was raining part of the time during the two manilla rope tests, and also during the test of one of the stevedore ropes. I do not think in this case that the weather cut very much figure in making these tests. Hereafter, we shall use the manilla rope entirely for pile-drivers. We were probably three months in making the tests that this report was compiled from.

Mr. Eilers.—I would like to ask Mr. Bishop the weight of the hammer they used for their driver.

Mr. Bishop.—Weight of hammer was 3,000 pounds.

Mr. Berg.—The conditions were as nearly alike as possible for all the ropes, as I understand.

Mr. Bishop.—The same hammer was used throughout.

Mr. Eilers.—We are using a 3,200 pound hammer on our driver, and we use manilla rope, and we have driven as high as 1,000 or 1,200 piles with it.

Mr. W. A. Rogers.—I will say that the Chicago, Milwaukee & St. Paul Ry. are at present making tests of various kinds of ropes for pile-driver hammer lines. In order to have two different ropes tested under the same conditions they are changed each day, one rope being used one day and the other the next. The tests are not yet completed.

XI. Gas Engines for Pumping Water.

REMARKS BY MR. SHANE.

Mr. A. Shane.—I want to introduce a subject that I believe will interest every member of the association. Supervisors of bridges and buildings, as a rule, have charge of the water stations and pumping of water, and are interested in all questions pertaining to that department. We all appreciate fully

how expensive that department has been in the past. On my division alone of four hundred miles on the C., C., C. & St. L. it costs us annually to operate water stations, $10,000, and, as the capacity of locomotive tanks has been increased from 1,800 to 4,000 gallons, it becomes imperative to adjust our water stations. And, while we had that matter under consideration, it was suggested that we endeavor to curtail the expense of pumping water to the lowest minimum. I was instructed to look about and suggest some means by which we could do this. When we had perfected our water system to that point where we could pump water at two and one-half cents (2½ cents) per thousand gallons, we thought we had accomplished quite a good deal, but our management were not yet satisfied. They wanted a still further reduction. We found that the only way to do this was to introduce a new method, and we could not do it with steam and coal; although in some localities we had natural gas for fuel, we found that we did not reduce the cost.

After looking the field over, the only means or the only power we had at our command to do this was a gas engine. This does reduce the expense of pumping water to a minimum, because it dispenses entirely with the pumper, dispenses entirely with the transportation of coal, with the handling of the coal, and in some cases, no doubt, with the purchasing price of coal. In our case it does not cost anything for coal as the miners are glad to get rid of it.

In looking over the field for gas engines I found what they call a crude oil engine. It will use gasoline, naphtha, natural gas, or crude oil. Considering the labor we had to employ being unskilled at all times, and frequently changing men, and sometimes men would have to be called upon who had never handled the plant and had no instructions in regard to it; possibly careless in handling the material, and understanding the nature of gasoline to be highly combustible, it struck me that this crude oil engine was preferable, from the fact that there is nothing highly combustible about it. It will not interfere with our insurance rates and it is more economical.

I suggested this engine to our company and they have purchased one, but we did not get it into operation before I left to

attend this meeting. I had hoped to do so, but our engineer having made arrangements to purchase a boiler from one company and the engine from another they did not make connection in time, but I think the plant is now in operation. I went to the factory, had the people set up the engine. put the pump to work and give it every conceivable test, so that I am satisfied what the result will be. I am safe in making the statement that instead of being at the expense of two and one-half cents for every thousand gallons of water pumped, I will pump it for one mill per thousand gallons.

Now the plan which I shall adopt is that we shall operate this engine, as far as the shutting down is concerned, automatically. We will place a float in the tub, and it will close the circuit and stop the engine. There will be an additional float in the tub, and when there is a capacity of supposing 100,000 gallons, it will be safe to allow it to subside to 50,000 gallons, and then the second float will ring a bell in the telegraph office giving warning. Any person about the station can start it, and the parts that can be gotten out of order are so slight, that we have no fear of trouble on that score.

I propose to take some of the old locomotive tanks that we are abandoning of 2,000 gallons capacity, set them up close to the pump house, and connect them directly with the pump. This oil does not flow into the pump, but is pumped into the engine and each stroke of the pump takes the required amount of oil into the cylinder and flows down through the cylinder, and the gas is extracted from that.

After we have got enough of these plants in operation, so that we can purchase a tank of oil, it is my purpose to get a full tank of oil and go from station to station and discharge it at the rate of 2,000 gallons to a station, so that we will have a job of that kind about every sixty or ninety days.

I propose to make this so complete, that the labor required will be so light and not requiring skilled labor, so that at some stations the agent can discharge the duty of attending to this pump and starting it. The pump repairer will have to attend to seeing that his reservoirs are filled at all times, when he is duly notified that they are in need of being filled.

I intend to make the pump house so tight that it will not be necessary to heat it artificially; make it frost proof, so that in the coldest weather it cannot possibly give us any trouble.

The plant now going in at Greensburg will pump water 9,000 feet. It will have an eight-inch main. When the plant is complete we will build an additional tub and pump 7,000 feet by putting in an eight-inch main, by overcoming the friction entirely, and expect to pump 150,000 gallons of water by running the engine fifteen hours at cost of ten cents. By buying the oil in large quantities we get it at less than one cent per gallon. There is a residue of oil from this engine after the gas is extracted, which is fifty per cent. of the original, and which is an excellent lubricating oil. We had not taken this into consideration, when I stated the cost at one mill per thousand gallons.

I am satisfied that these engines are destined to revolutionize pumping stations and that most thoroughly. I think it is his duty where he can for a man occupying the position we do to set forth such an important feature as this saving is destined to be.

LIST OF ANNUAL CONVENTIONS.

First Convention,	St. Louis, Mo.,	September 25, 1891.
Second Convention,	Cincinnati, Ohio,	October 18, 19, 1892.
Third Convention,	Philadelphia, Pa.,	October 17 to 19, 1893.
Fourth Convention,	Kansas City, Mo.,	October 16 to 18, 1894.
Fifth Convention,	New Orleans, La.,	October 15, 16, 1895.
Sixth Convention,	Chicago, Ill.,	October 20 to 22, 1896.
Seventh Convention,	Denver, Col.,	October 19 to 21, 1897.

MEMBERSHIP.

Year 1891–2. . . .	Number of active members, 60.
Year 1892–3. . . .	Number of active members, 112.
Year 1893–4. . . .	Number of active members, 128.
Year 1894–5. . . .	Number of active members, 115.
Year 1895–6. . . .	Number of active members, 122.
Year 1896–7. . . .	Number of active members, 140.
Year 1897–8. . . .	Number of active members, 127.

LIST OF OFFICERS OF THE ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS FROM THE ORGANIZATION OF THE ASSOCIATION TO THE YEAR 1897-'98.

YEAR.	1891-2.	1892-3.	1893-4.	1894-5.
President	O. J. Travis	H. M. Hall	J. E. Wallace	Geo. W. Andrews.
First Vice-President	H. M. Hall	J. E. Wallace	Geo. W. Andrews	W. A. McGonagle.
Second Vice-President	J. B. Mitchell	G. W. Hinman	W. A. McGonagle	L. K. Spafford.
Third Vice-President	James Stannard	N. W. Thompson	L. K. Spafford	James Stannard.
Fourth Vice-President	G. W. Hinman	C. E. Fuller	E. D. Hines	Walter G. Berg.
Secretary	C. W. Gooch	S. F. Patterson	S. F. Patterson	S. F. Patterson.
Treasurer	George M. Reid	George M. Reid	George M. Reid	George M. Reid.
Executive Members	W. R. Damon	G. W. Andrews	Quintine McNab	James Stannard.
	G. W. Markley	Joseph M. Staten	Aaron S. Markley	James H. Travis.
	W. A. McGonagle	J. M. Caldwell	Floyd Ingram	Joseph H. Cummin.
	G. W. McGehee	Quintine McNab	James Stannard	R. M. Peck.
	G. W. Turner	Floyd Ingram	James H. Travis	J. L. White.
	J. E. Wallace	Aaron S. Markley	Joseph H. Cummin	A. Shane.

YEAR.		1895-6.	1896-7.	1897-8.
President		W. A. McGonagle	James Stannard	Walter G. Berg.
First Vice-President		L. K. Spafford	Walter G. Berg	Joseph H. Cummin.
Second Vice-President		James Stannard	Joseph H. Cummin	Aaron S. Markley.
Third Vice-President		Walter G. Berg	Aaron S. Markley	G. W. Hinman.
Fourth Vice-President		Joseph H. Cummin	R. M. Peck	C. C. Mallard.
Secretary		S. F. Patterson	S. F. Patterson	S. F. Patterson.
Treasurer		George M. Reid	N. W. Thompson	N. W. Thompson.
Executive Members		R. M. Peck	W. O. Eggleston	George J. Bishop.
		J. L. White	W. M. Noon	C. P. Austin.
		A. Shane	Joseph M. Staten	M. Riney.
		Aaron S. Markley	George J. Bishop	Wm. S. Danes.
		W. M. Noon	C. P. Austin	J. H. Markley.
		Joseph M. Staten	M. Riney	W. O. Eggleston.

SUBJECTS FOR REPORT AND DISCUSSION, AND COMMITTEES SELECTED AT EACH CONVENTION SINCE ORGANIZATION OF THE ASSOCIATION IN 1891.

FIRST CONVENTION, ST. LOUIS, MO., SEPTEMBER 25, 1891.

Subjects.	Committees.
1. Surface Cattle-Guards	Aaron S. Markley, J. B. Mitchell, W. R. Damon.
2. Frame and Pile Trestles Complete, including Rerailer	H. M. Hall, W. A. McGonagle, G. W. McGehee.
3. Framing and Protection of Howe Truss and Other Wooden Bridges against Fire and Decay	J. E. Johnson, G. W. Markley, J. H. Markley.
4. Iron and Vitrified Pipe for Waterways under Railroad Embankments	James Stannard, J. O. Thorn, J. E. Wallace.
5. Water-Tanks Complete, including Painting, Pumps, Pump and Coal Houses, Wells and Reservoirs	G. W. Turner, R. K. Ross, Q. McNab.
6. Interlocking Signals	B. F. Bond, G. W. Hinman, James Demars.
7. Depot Platforms, Complete	J. A. Nicholson, Adam McNab, C. B. Keller.
8. Paints for Iron Structures	Geo. M. Reid, A. J. Kelley, H. A. Hanson.

SECOND CONVENTION, CINCINNATI, O., OCTOBER 18 AND 19, 1892.

Subjects.	Committees.
1. Discipline, and Benefits Derived, and Who are the Beneficiaries	Geo. W. Andrews, W. R. Damon, T. M. Strain, G. W. Turner.
2. Turn-table, Best, with a View of Economy, and Durability, and Strength	G. W. Markley, H. F. Martin, James H. Travis, Charles Walker.
3. Water Columns, Best, Cheapest, Simplest, and Most Durable	C. E. Fuller, A. S. Markley, H. N. Spaulding, E. L. Cary.
4. Coaling Stations, including Storage Bins and for Coaling Engines	J. E. Wallace, C. W. Gooch, G. W. Hinman, J. H. Cummin.

5. Crawling of Rails, and its Effects on Structures......	Geo. M. Reid, L. K. Spafford, J. B. Mitchell, L. S Isdell.
6. Guard-Rails on Bridges, Advantages and Disadvantages, and Best to be Adopted	O. J. Travis, Q. McNab, J. F. Mock, J. M. Staten.
7. Platforms, Height and Distance from Rail and Mode of Construction..	James Stannard, M. Walsh, N. M. Markley, Robert Ogle.
8. Best Bridge, Wood, Combination, or Iron, from 130 feet and upwards, and the Best Method of Reconstruction..	A. Shane, Walter Ransom, N. Potter, C. G. Worden.
9. Best Method of Elevating Track upon Bridges and Trestles	H. E. Gettys, S. F. Patterson, G. W. Hinman, P. N. Watson.

THIRD CONVENTION, PHILADELPHIA, PA., OCT. 17, 18, AND 19, 1893.

1. Depressed Cinder Pits and Other Kinds	W. G. Berg, Abel S. Markley, G. W. Andrews, C. E. Fuller.
2. Best Method of Bridge Inspection................. ...	G. M. Reid, J. M. Staten, Geo. J. Bishop, J. S. Berry.
3. Pumps and Boilers...	G. W. Markley, G. W. Turner, J. B. Mitchell, J. R. Harvey.
4. Maintenance of Pile and Frame Trestle...............	W. A. McGonagle, J. H. Markley, Geo. C. Nutting, John Copeland.
5. The Best Scale Foundation..................	O. J. Travis, Joseph Doll, C. D. Bradley, T. M. Strain.

FOURTH CONVENTION, KANSAS CITY, MO., OCT. 16, 17, AND 18, 1894.

1. Mechanical Action and Resultant Effects of Motive Power at High Speed on Bridges	G. W. Andrews, W. G. Berg, J. E. Greiner, E. H. R. Green.
2. Methods and Special Appliances for Building Temporary Trestles over Washouts and Burnouts......	R. M. Peck, G. J. Bishop, A. B. Manning, C. D. Bradley.
3. Strength of Various Kinds of Timber Used in Trestles and Bridges, Especially with Reference to Southern Yellow Pine, White Pine, Fir, and Oak...	W. G. Berg, J. H. Cummin, John Foreman, H. L. Fry.

4.		
Best Method of Erecting Plate-Girder Bridges.......		H. M. Hall, J. M. Staten, G. W. Hinman, J. N. Pullen.
5.		
Best and Most Economical Railway Track Pile-Driver..		J. L. White, A. C. Davis, J. F. Mock, James T. Carpenter.
6.		
Sand Dryers, Elevators, and Methods of Supplying Sand to Engines, including Buildings..............		Aaron S. Markley, H. A. Hanson, A. J. Kelley, J. O. Thorn.
7.		
Span Limits for Different Classes of Iron Bridges, and Comparative Merits of Plate-Girders and Lattice-Bridges for Spans from 50 to 110 feet...........		W. A. McGonagle, R. M. Peck, W. M. Noon, H. E. Gettys.
8.		
Best Method of Spanning Openings too Large for Box Culverts, and in Embankments too Low for Arch Culverts..		James Stannard, L. K. Spafford, O. H. Andrews, F. W. Tanner.
9.		
Best End Construction for Trestle Adjoining Embankments..		G. M. Reid, J. L. Soisson, N. M. Markley, R. J. Howell.
10.		
Interlocking Signals....................................		J. H. Travis, W. S. Danes, R. L. Heflin, J. A. Spangler.
11.		
Pumps and Boilers......................................		John H. Markley, O. J. Travis, A. Shane, G. W. Markley.

FIFTH CONVENTION, NEW ORLEANS, LA., OCTOBER 15 AND 16, 1895.

1.		
How to Determine Size and Capacity of Openings for Waterways..		Aaron S. Markley, J. S. Berry, C. C. Mallard, J. L. White.
2.		
Different Methods of Numbering Bridges. Should All Waterways be Numbered ?.......................		A. Shane, W. O. Eggleston, J. L. Slosson, O. J. Travis.
3.		
Drawbridge Ends, Methods of Locking; and under this head include Locking of Turn-tables...........		H. M. Hall, James Stannard, H. Middaugh, C. C. Mallard.
4.		
Protection of Trestles from Fire, including Methods of Construction..		R. M. Peck, T. H. Kelleher, A. McNab, W. M. Noon, G. W. Hinman, William Berry.
5.		
Local Stations for Small Towns and Villages, giving Plans of Buildings and Platforms....................		J. H. Cummin, N. M. Markley, J. H. Markley, C. G. Worden.
6.		
Tanks, Size, Style, and Details of Construction, including Frost-proof protection to Tank and Pipes..		W. O. Eggleston, W. M. Noon, A. McNab, N. W. Thompson.

7.

Shearing of Rivets in Plate-Girders and Cause Thereof..	J. M. Staten, R. L. Heflin, J. H. Travis, G. M. Reid.

8.

Best and Uniform System of Report Blanks for Bridge and Building Department....................	G. J. Bishop, W. O. Eggleston, Onward Bates, M. Riney.

9.

Protection of Railroad Structures and Buildings from Fire..	R. M. Peck, L. K. Spafford, B. T. McIver.

10. Brought forward from 1894.

Mechanical Action and Resultant Effects of Motive Power at High Speed on Bridges....................	G. W. Andrews, W. G. Berg, J. E. Greiner, E. H. R. Green.

11. Brought forward from 1894.

Best and Most Economical Railway Track Pile-Driver..	J. L. White, A. C. Davis, J. F. Mock, J. T. Carpenter, G. W. Hinman.

12. Brought forward from 1894.

Span Limits for Different Classes of Iron Bridges, and Comparative Merits of Plate-Girders and Lattice Bridges for Spans from 50 to 110 feet............	W. A. McGonagle, R. M. Peck, W. M. Noon, H. E. Gettys, G. J. Bishop, Onward Bates.

13. Brought forward from 1894.

Interlocking Signals....................................	J. H. Travis, W. S. Danes, R. L. Heflin, J. A. Spangler.

SIXTH CONVENTION, CHICAGO, ILL., OCTOBER 20, 21, AND 22, 1896.

1.

Methods of Heating Buildings where Three or More Stoves are Now Used..................................	J. H. Cummin, George W. Hinman, George W. Markley, Wm. Berry.

2.

The Most Suitable Material for Roofs of Buildings of All Kinds..	R. M. Peck, G. W. Turner, W. M. Noon, N. W. Thompson.

3.

Roundhouse Construction, including Smoke-jacks and Ventilators..	Geo. W. Andrews, O. J. Travis, W. O. Eggleston, James T. Carpenter.

4.

Care of Iron Bridges after Erection...................	James H. Travis, T. M. Strain, H. M. Hall, Walter Rogers.

5.

How to Determine Size and Capacity of Openings for Waterways..	Walter G. Berg, Aaron S. Markley, Onward Bates, A. J. Kelley.

6.

Protection of Railroad Buildings and Other Structures from Fire .... — W. A. McGonagle, M. M. Garvey, J. D. Hilderbrand, John Foreman.

7.

Designs for Ice-Houses .... — W. B. Yereance, C. M. Large, J. H. Markley, Geo. W. Ryan.

8.

Best End Construction for Trestles adjoining Embankments .... — C. C. Mallard, W. S. Danes, R. L. Heflin, A. C. Olney.

9.

Bridge Warnings for Low Overhead Structures .... — W. E. Harwig, M. A. Martin, E. H. R. Green, Joseph Doll.

10.

Stock-yards and Stock-sheds, including all Details of Construction .... — Geo. J. Bishop, W. R. Cannon, O. H. Andrews, James Brady.

11.

Floor System on Bridges, including Skew Bridges .... — W. G. Guppy, C. P. Austin, C. W. Gooch, F. W. Tanner.

SEVENTH CONVENTION, DENVER, COL., OCTOBER 19, 20, AND 21, 1897.

1.

Pile-rings and Method of Protecting Pileheads in Driving .... — G. W. Hinman, Wm. S. Danes, F. Eilers, E. F. Reynolds, Wm. Carmichael, C. M. Large.

2.

Cost and Manner of Putting In Pipe Culverts .... — Walter A. Rogers, Frank W. Tanner, John H. Markley, A. H. King, B. F. Bond, O. H. Andrews.

3.

Best Floors for Shops and Roundhouses .... — A. W. Merrick, C. S. Thompson, Wm. O. Eggleston, M. F. Cahill, J. B. Pullen, James Gilbert.

4.

Roundhouse Smoke-jacks and Ventilation .... — George W. Andrews, Wm. O. Eggleston, Aaron S. Markley, R. J. Howell, J. T. Carpenter, A. McNab.

5.

Cattleguards and Wingfences .... — C. C. Mallard, C. S. Thompson, A. Zimmerman, L. H. Wheaton, O. W. Osborne, R. L. Heflin.

6.

Prevention of Fire in Railroad Buildings .... — John D. Isaacs, Wm. A. McGonagle, M. Riney, H. L. Fry, J. P. Snow, Wm. B. Yearance.

7.		
Storage of Fuel, Oil, and Other Station Supplies at Way-stations		Arthur Montzheimer, A. Shane, G. E. Hanks, J. E. Johnson, W. Z. Taylor, E. M. Gilchrist.
8.		
Railroad Highway Crossing Gates		Joseph H. Cummin. J. B. Sheldon, Wm. E. Harwig, G. W. Smith, J. E. Featherston, W. M. Noon.
9.		
What Repairs, and How Can they be Safely Made, to Metal and Wooden Spans Without the Use of False-work		F. S. Edinger, B. W. Guppy, J. E. Greiner, John D. Isaacs, Walter A. Rogers, H. W. Fletcher.
10.		
Care of Iron Bridges After Erection, including Best Method of Protecting Them From Injury by Salt Water Drippings from Refrigerator cars		J. E. Greiner, B. W. Guppy, James McIntyre, T. M. Strain, A. J. Kelley, L. F. Goodale.
11.		
Turntable Construction		Onward Bates, J. B. Sheldon, D. K. Colburn, John Foreman, E. Fisher, Henry Goldmark.

CONSTITUTION.

ARTICLE I.

NAME.

SECTION 1. This Association is known as the "Association of Railway Superintendents of Bridges and Buildings."

ARTICLE II.

OBJECT.

SECTION 1. The object of this Association shall be the mutual advancement of its members, by the acquirement of more perfect knowledge in the construction, maintenance, and repair of railroad bridges and buildings, as well as all other matters entrusted to the care of superintendents of bridges and buildings, by common discussion, interchange of ideas, reports, and investigations of its members.

ARTICLE III.

MEMBERSHIP.

SECTION 1. Any person at the head of a bridge and building department on any railroad, or a division or subdivision, and to include assistant superintendent and general foreman of any railroad, shall be eligible to membership in this Association upon application to the Secretary and the payment of $3.00 membership fee and $3.00 for one year's dues, membership to continue until written resignation is received by the Secretary, unless member has been previously expelled.

SEC. 2. Any member guilty of dishonorable conduct, or conduct unbecoming a railroad official and member of this Association, or who shall refuse to obey the chairman, or rules of this Association, may be expelled by a two-thirds vote of the members present.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of this Association shall be a president, four vice-presidents, a secretary, a treasurer, and six executive members. The executive members, together with the president, secretary, and treasurer, shall constitute the Executive Committee.

All Past-Presidents of this Association, who continue to be members, shall be entitled to be present at all meetings of the Executive Committee, of which meetings they shall receive due notice, and be permitted to discuss all questions coming before the Executive Committee and to aid said committee by their advice and counsel; but, said Past-Presidents shall not have a right to vote, nor shall their presence be requisite in order to constitute a quorum.

ARTICLE V.

DUTIES OF OFFICERS.

SECTION 1. The duties of officers shall be such as prescribed by by-laws, as pertain to officers of like character, general, or may be assigned them by the Executive Committee.

ARTICLE VI.

EXECUTIVE COMMITTEE.

SECTION 1. The Executive Committee shall exercise a general supervision over the financial and other interests of the Association, assess the amount of annual and other dues, call, prepare for, and conduct general or special meetings, make all necessary purchases and contracts required to conduct the general business of the Association, but shall not have power to render the Association liable for any debt beyond the amount then in the treasurer's hands not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the Association.

SEC. 2. The Executive Committee shall report the proceedings of its meetings, making such reports accessible to members; it shall publish the proceedings of all meetings of the Association, subject to the approval of the Association.

SEC. 3. Two thirds of the members of the Executive Committee may call special meetings, sixty days' notice being given members by mail.

SEC. 4. Five members of the Executive Committee shall constitute a quorum for the transaction of business.

ARTICLE VII.

ELECTION OF OFFICERS AND TENURE OF OFFICE.

SECTION 1. The officers, excepting as otherwise provided, shall be elected at the regular meeting of the Association, held on third Tuesday in October of each year, and the election shall not be postponed except by unanimous consent.

PRESIDENT AND TREASURER.

SEC. 2. The president and treasurer shall be elected by ballot by a majority of votes cast, and shall hold office for one year, or until successors are elected.

VICE-PRESIDENTS AND EXECUTIVE MEMBERS.

SEC. 3. The vice-presidents shall hold office for one year and executive members for two years, four vice-presidents, and three executive members to be elected each year; provided, however, that three of the executive members be appointed by the president at the adoption of this constitution. All officers herein named to hold office until successors are chosen at next annual meeting.

SEC. 4. In the election of vice-presidents, each one shall be elected by a majority vote. Executive members will be elected in the same way, all voting to be by written ballots.

SECRETARY.

SEC. 5. A secretary shall be elected by a majority of the votes of the members present at the annual meeting. The term of office of the secretary shall be for one year, unless terminated sooner by action of the Executive Committee, two-thirds of whom may remove the secretary at any time. His compensation shall be fixed by a majority of the Executive Committee. The secretary shall also be secretary of the Executive Committee.

TREASURER.

SEC. 6. The treasurer shall be required to give bond in an amount to be fixed by the majority of the Executive Committee.

ARTICLE VIII.

COMMITTEES.

SECTION 1. At the first session of the annual meeting the president shall appoint a committee of three members, not then officers of the Association, who shall send names of nominees for officers of the Association for the ensuing year to the secretary, before the election of officers is in order, and the names shall be announced as soon as received. The election shall not be held until the day after announcement, except by unanimous consent. Nothing in this section shall be construed to prevent any members from making nominations.

AUDITING COMMITTEE.

SEC. 2. At the first session of each annual meeting there shall be appointed by the president an auditing committee of three members, not officers of the Association, whose duty it shall be to examine the accounts and vouchers of the treasurer and certify as to the correctness of his accounts. Acceptance of this committee's report will be regarded as the discharge of the committee.

COMMITTEES ON SUBJECTS FOR DISCUSSION.

SEC. 3. At the annual meeting there shall be appointed by the president a committee, whose duty it shall be to prepare and report subjects for discussion and investigation at the next annual meeting. If subjects are approved by the Association, the president shall appoint a committee to report on them. It shall be the duty of the committee to receive from members questions for discussion during the time set apart for that purpose. This committee shall be the judge of whether such questions are suitable ones for discussion, and if so, report them to the Association.

COMMITTEES ON INVESTIGATION.

SEC. 4. When the committee on subjects has reported and the Association approved of the same, the president shall appoint special committees to investigate and report on said subjects. and he may appoint a special committee to investigate and report on any subject which a majority of members present may approve of.

ARTICLE IX.

ANNUAL DUES.

SECTION 1. Every member shall pay to the treasurer three dollars membership fee, and shall also pay three dollars per year in advance to defray the necessary expenses of the Association. No member being one year in arrears for dues will be entitled to vote at any election, and any member one year in arrears may be stricken from the list of members at the discretion of the Executive Committee.

ARTICLE X.

AMENDMENTS.

SECTION 1. This constitution may be amended at any regular meeting by a two-thirds vote of members present, provided that a written notice of the proposed amendment has been given at least ninety days previous to said regular meeting.

BY-LAWS.

TIME OF MEETING.

1. The regular meeting of this Association shall be held annually on the third Tuesday in October.

HOUR OF MEETING.

2. The regular hour of meeting shall be at 10 o'clock a. m.

PLACE OF MEETING.

3. The cities or places for holding the annual convention may be proposed at any regular meeting of the Association before the final adjournment. The places proposed shall be submitted to a ballot vote of the members of the Association, the city or place receiving a majority of all the votes cast to be declared the place of the next annual meeting; but if no place received a majority of all votes, then the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

QUORUM.

4. At the regular meeting of the Association, fifteen or more members shall constitute a quorum.

ORDER OF BUSINESS.

5. 1st—Calling of roll.
   2d—Reading minutes of last meeting.
   3d—Admission of new members.

4th—President's address.
5th—Reports of secretary and treasurer.
6th—Payment of annual dues.
7th—Appointment of committees.
8th—Reports of committees.
9th—Unfinished business.
10th—New business.
11th—Reading and discussion of questions propounded by members.
12th—Miscellaneous business.
13th—Election of officers.
14th—Adjournment.

DUTIES OF OFFICERS.

6. It shall be the duty of the president to call the meeting to order at the appointed time; to preside at all meetings; to announce the business before the Association, and to decide all questions of order and sign all orders drawn on the treasurer.

7. It shall be the duty of the vice-presidents, in the absence of the president, to preside at all meetings of the Association, in their order named.

8. It shall be the duty of the secretary to keep a correct record of proceedings of all meetings of this Association; to keep correct all accounts between this Association and its members; collect all moneys due the Association, and pay the same over to the treasurer and take his receipt therefor, and to perform such other duties as the Association may require.

9. It shall be the duty of the treasurer to receive and receipt to the secretary for all moneys received from him, and pay all orders authorized by the Association.

DECISIONS.

10. The votes of a majority of members present shall decide any question, motion, or resolution which shall be brought before the Association, unless otherwise provided.

DISCUSSIONS.

11. All discussions shall be governed by Roberts' Rules of Order.

DIRECTORY OF MEMBERS.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.

OCTOBER, 1897.

ANDREWS, GEORGE W., Philadelphia Div. B. & O. R. R., Wilmington, Del.
ANDREWS, O. H., St. Jo. & G. I. & K. C. Ry., St. Joseph, Mo.
AUSTIN, CYRUS P., B. & M. R. R., Medford, Mass.
BATES, ONWARD, C., M. & St. P. Ry., and M. & N. Ry., Chicago, Ill.
BERG, WALTER G., Lehigh Valley Ry., Jersey City, N. J.
BERRY, J. S., S. T. S. W. Ry., Tyler, Texas.
BERRY, WILLIAM, San Antonio & Arkansas Pass Ry., Yoakum, Texas.
BISHOP, GEORGE J., C., R. I. & P. Ry., Topeka, Kan.
BRICKER, J. A., Norfolk & Western Ry., Shenandoah, Va.
BOND, B. F., Jacksonville & St. Louis Ry., Jacksonville, Ill.
BOYCE, JOSEPH W., L. E. & St. L. C. R. R., Huntingburgh, Ind.
BRADY, JAMES, Chicago, Rock Island & Pacific Ry., Davenport, Iowa.
CANNON, W. R., C. R. I. & P. Ry., Herington, Kan.
CARMICHAEL, WILLIAM, U. Pac. R. R., Junction City, Kan.
CARPENTER, JAMES T., Chicago, Rock Island & Pacific R. R., Topeka, Kan.
CARY, E. L., M. R. & B. T. R. R., Bonne Terre, Mo.
CAHILL, M. F., 412 C St., Lynchburg, Va.
COLBURN, D. K., Atlantic System, Southern Pacific Ry., Houston, Texas.
CUMMIN, JOSEPH H., Long Island R. R., Long Island City, N. Y.
DAMON, W. R., Louisville, Nashville & St. L. Rd. Co., Huntingburgh, Ind.
DANES, WILLIAM S., Wabash R. R., Eastern Div., 102 Ewing St., Peru, Ind.
DOLL, JOSEPH, C., C., C. & St. L. Ry. Co., Batesville, Ind.
EDINGER, FRED S., Pacific System, Southern Pacific Ry., San Francisco, Cal.
EGGLESTON, WILLIAM O., C. & Erie R. R., Huntington, Ind.
EILERS, FRED, Chicago, Burlington & Quincy R. R., Ottumwa, Ia.
ENNES, I. R., South Carolina & Georgia R. R., Branchville, S. C.
FEATHERSTON, J. E., Missouri Pacific Ry., Osawatomie, Kan.
FISHER, E., Missouri Pacific Ry., Pacific, Mo.
FLETCHER, HOLLAND W., C. & N. W. Ry., 22 5th Ave., Chicago, Ill.
FOREMAN, JOHN, Phila. & Read. R. R., Pottstown, Pa.
FRY, H. L., Cape Fear & Yadkin Valley R. R., Greensboro, N. C.
GARVEY, M. M., Iowa Central R. R., Marshalltown, Iowa.
GILBERT, JAMES, M. K. & Texas Ry., Parsons, Kansas.
GILCHRIST, ED. M., Hannibal & St. Joseph R. R., Brookfield, Mo.
GOOCH, C. W., 1325 West 9th St., Des Moines, Iowa.
GOODALE, L. F., Hannibal & St. Joseph R. R., St. Joseph, Mo.
GOLDMARK, HENRY, 1731 Monadnock Block, Chicago, Ill.
GREEN, E. H. R., Texas Midland R. R., Terrell, Texas.
GREINER, J. E., B. & O. R. R., Baltimore, Md.
GUPPY, B. W., B. & M. R. R., Boston, Mass.

HALL, H. M., Ohio & Miss. Ry., Olney, Ill.
HANKS, GEORGE E., Flint & Pere Marquette Ry., East Saginaw, Mich.
HARVEY, JAMES R., St. L., I. M. & S. Ry., Little Rock, Ark.
HARWIG, WILLIAM E., Lehigh Valley R. R., Phillipsburg, N. J.
HEIDLER, W. H., N. & W. Ry., Shenandoah, Va.
HEFLIN, R. L., B. & O. Ry., Grafton, W. Va.
HOWELL, ROBERT J., Wheeling Bridge & Terminal Ry., Wheeling, W. Va.
HINMAN, G. W., Louisville & Nashville R'd Co., Evansville, Ind.
INGRAM, FLOYD, Louisville & Nashville R'd Co., Erin, Tenn.
ISAACS, JOHN D., Southern Pacific Co., SanFrancisco, Cal.
JOHNSON, J. E., Toledo, St. Louis & Kansas City R'd, Frankfort, Ind.
KELLEHER, T. H., New Orleans & N. E. R'd Co., New Orleans, La.
KELLEY, A. J., K. C. Belt Ry. Co., Kansas City, Mo.
KING, A. H., Union Pacific Ry., Cheyenne, Wyo.
KLUMP, G. J., C., C., C. & St. L. Ry., Mattoon, Ill.
KYSER, CHARLES W., Mo. Pacific R. R., El Dorado, Kansas.
LARGE, C. M., Erie & Pittsburgh Ry., Jamestown, Pa.
LOUGHERY, E., Texas & Pacific Ry., Marshall, Texas.
MARKLEY, AARON S., Chicago & Eastern Ill. R. R. Co., Danville, Ill.
MARKLEY, JOHN H., Toledo, Peoria & Western Ry. Co., Peoria, Ill.
MARKLEY, N. M., C., C., C. & St. L. Ry. Co., Arcanum, Ohio.
MALLARD, CHARLES C., Southern Pacific Ry., Algiers, La.
MANNING, A. B., M., K. & T. Ry., Parsons, Kansas.
MARTIN, M. A., M., K. & T. Ry., Parsons, Kansas.
McGEHEE, G. W., Mobile & Ohio R'd Co., Okolona, Miss.
McGONAGLE, W. A., Duluth & Iron Range R'd Co., Two Harbors, Minn.
McIVERS, B. T., St. Paul & Duluth Ry. Co., St. Paul, Minn.
McINTYRE, JAMES, Mahoning Div. Erie R. R., Central Depot, Cleveland, Ohio.
McNAB, A., Chi. & West Mich. Ry., Holland, Mich.
MERRICK, A. W., Chicago & Northwestern Ry., Huron, S. D.
MIDDAUGH, H., Seattle, Lake Shore & Eastern Ry. Co., Seattle, Wash.
MILLENER, S. S., B. & O. Southwest R. R., Washington, Ind.
MITCHELL, W. B., N. Y., P. & O. R. R., Galion, Ohio.
MOCK, J. F., Ohio River R'd Co., Parkersburg, W. Va.
MONTENEIMER, ARTHUR, Chicago & Northwestern Ry., Milwaukee, Wis.
NEFF, J. L., C. Nor. Pac. & C. Ry., 358 Grand Central Depot, Chicago, Ill.
NUTTING, GEORGE C., O. R. & C. R. R., Blacksburg, S. C.
NOON, W. M., Duluth, South Shore & Atlantic Ry., Marquette, Mich.
OLNEY, A. C., Charleston, S. C.
OLMSTEAD, J. O., Central Vermont R. R., St. Albans, Vt.
OSBORNE, FRANK C., Valley Ry., Cleveland, Ohio.
OSBORNE, A. W., Northern Pacific R. R., Tacoma, Wash.
PATTERSON, SAMUEL F., Boston & Maine R. R., Concord, N. H.
POTTER, M. F., C., C., C. & St. L. Ry. Co., Franklin, Ohio.
PULLEN, J. B., B. & O. S. W. Ry., Chillicothe, Ohio.
REED, WILLIAM, JR., Ill. Cent. R. R., Chicago, Ill.
REYNOLDS, EDWARD F., C. & N. W. Ry., Ashland, Wis.
ROSS, R. K., Detroit, Lansing & Northern Ry., Iona, Mich.
ROGERS, JAMES, N. Y. C. & St. L. R. R., Fort Wayne, Ind.
ROGERS, WALTER A., C., M. & St. P. Ry., Chicago, Ill.
RYAN, GEORGE W., K. C., Fort Scott & Memphis Ry. Co., Thayer, Ore. Co., Mo
RINEY, M., C. & N. W. R. R., Barraboo, Wis.
SCHENCK, W. S., B. & O. R. R. (P. H. Div.), Connellsville, Pa.
SHANE, A., C., C., C. & St. L. Ry. Co., 85 College Ave., Indianapolis, Ind.
SHELDON, J. B., New York, New Haven & Hartford R. R., Woonsocket, R. I.
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